Human Resource Planning for the Mining Industry

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Edited by
L. Moira Jackson

Centre for Resource Studies

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L. Moira Jackson

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Preface

The Centre's decision to hold a seminar on human resource management in the mining industry was prompted by the disturbing trend of seriously declining enrolment in university programs related to mining. After consultation with a number of industry executives, the topic was refined to human resource planning, because of a general belief that the industry was about to suffer a severe shortage of appropriately skilled employees at all levels, from production to senior management.

This belief was by no means universal, as we discovered in the process of recruiting speakers and other participants. It was most prevalent in large companies, those with the resources to train their own workers, and considered least serious by the medium-sized and small companies. The latter were frank to admit that they survived very nicely by recruiting from the large companies that had made the necessary investment in training.

Nevertheless, it was viewed as a problem by such a wide range of organizations and individuals that CRS decided to draw together a group of people with an interest and expertise in resolving the difficulty of attracting and retaining a workforce of adequate size and skills in mining and mineral processing. The topic was generally considered to encompass the image of mining as a profession, the industry's needs, the nature of employment in mining, and issues in education and human resource management related to the industry.

The seminar attracted interest from across Canada, as well as participants from Australia, the United Kingdom and Finland. Besides representatives from industry and labour, there was a high degree of interest from a variety of university departments (ranging from mining engineering to industrial relations). An interesting development was that we failed completely to induce any provincial or federal department or agency with responsibility for educational or training issues to send a representative. This is a most important perspective to be lacking, in view of the fundamental need for coordination among the users and the providers of basic education and advanced education and skills training.

A significant feature of CRS seminars is the focus on free discussion, uninhibited by concern about being quoted, either in or out of context. To this end, the seminar was designed to have fewer major addresses than a typical conference, and to bring together a number of panels staffed with a range of opinion and perspective on the major issues. These panels were to serve as catalysts to discussion and, ultimately, to a plan of action for resolving the problems identified. Such a plan did evolve, and the results may be seen in the Epilogue, which follows the texts of the formal addresses and

introductory remarks of the panelists and a digest of the discussions (in which, of course, confidentiality of the speakers is respected).

It is clear that there are many constituencies with an interest in the areas surrounding the fundamental issue of ensuring that the mining industry meets its recruiting needs. The purpose of the seminar was to bring together knowledgeable individuals from the various stakeholders in the hope that an exchange of views and information might produce useful proposals for future action. The seminar drew together thirty-eight people, representatives of these constituencies, and individuals from other areas with experience that seemed to have some useful lessons for the mining industry. Through this combination of formal addresses, panels, open discussions, and informal interaction, the participants considered the industry's problems, their underlying causes, their implications and possible solutions.

In the opening address, Brian Ferguson, Vice President Mining for Falconbridge Ltd. and Chair of the Ontario Government's Advisory Committee on Mining Education, set the stage by describing the challenges facing the industry in this area in the 1990s. He identified several points that are general sources of concern in the industry and offered insights and suggestions for dealing with them.

Ed McDonnell from Energy Mines and Resources Canada opened the first morning session with an analysis of the trends and outlook for the skill mix among mining industry workers. This provided the perspective for a panel discussion on the future needs of the industry. The panel, chaired by Patrick MacCulloch, retired President and CEO of BP Selco and now a mining industry consultant, provided three different views of the problems: from industry, government and academe. Paul Parker, Vice President Administration for Inco, described Inco's approach to manpower planning; Nöel Billette of CANMET spoke from the viewpoint of government, combined with his perspective as chairman of the Canadian Institute of Mining, Metallurgy and Petroleum's Education Committee; George Poling, professor of mining at the University of British Columbia, spoke to issues in which he is involved during his two-year sabbatical to the Mining Association of British Columbia.

Professor Will Bawden, Chair in Mine Design and recently appointed Head of the Department of Mining Engineering at Queen's University, addressed past, present and potential problems arising from the industry's image as employer and corporate citizen. He was followed by a panel discussion on multiskilling, chaired by Les Brown of Hemlo Gold. Tom Reid of the United Steelworkers of America argued that improved trades training and transportability of certification among the provinces would serve the industry better than multiskilling, which would have the effect of diluting rather than enhancing the skills of mineworkers. As Chief Rock Mechanics Engineer for Falconbridge's Sudbury operations, Steve Flewelling disagreed, believing that the flexibility produced by multiskilling was more valuable to

both the company and the employee than the rigid segregation of the present system.

The luncheon speaker was John MacDougall, Parliamentary Secretary to the Minister of Energy Mines and Resources Canada. As MP for Timiskaming, an area very much affected by any matters concerning the resource industries, Mr. MacDougall has a particular interest in employment issues related to mining and directed his address to trades-related problems.

An afternoon panel discussion chaired by Professor Peter Richardson of the School of Business at Queen's, and also a consultant to the mining industry, offered the experience of other organizations in coping with problems similar to those faced by the mining industry. Northern Telecom's Vice President Human Resources, Tom Hennebury, gave a particularly helpful commentary on his firm's programs, which are designed to increase awareness of Northern Telecom's activities and the opportunities it offers to employees, and to improve its community image. As Canada's largest "consumer" of engineering graduates, Northern Telecom has much to teach other industries about cooperative interaction with the producers of these graduates. Arnold Bock discussed the Ontario government's Northern Ontario Relocation Program, which is dealing with the difficulties involved in inducing employees to move from the amenities of Toronto life to the perceived exigencies of "life in the wilderness."

The Prospectors and Developers Association asked Professor John Dixon, Head of the Department of Geological Sciences at Queen's University, to give a brief outline of the situation facing most Canadian university geology departments. With the exception of Queen's, enrolment at Canadian universities has declined to an alarming level. This has implications both for universities (because fluctuating demand makes decisions on staffing and resource allocation very difficult) and for the mining industry (because exploration companies may find themselves unable to hire geologists, resulting in diminishing ore reserves).

John Gordon, professor of business strategy at Queen's School of Business, gave an evening address on the interaction between industry and universities, offering a number of practical insights into problems and issues of management education. He also discussed some of the initiatives arising from a 1985 National Workshop on Management and Technology, many of which have direct applicability to the mining industry and can provide advice and guidance on coping with its rapidly changing workforce requirements.

This theme was developed further by Peter Richardson in his address on the topic of how mining managers are trained, both initially and on a continuing basis. One of the highlights of the seminar was the presentation by Odwyn Jones, Principal and Dean of the Western Australian School of Mines in Kalgoorlie, Australia. Dr. Jones gave participants the benefit of his experience and his imaginative approach to counteracting the negative factors

that had produced problems in Australia similar to those facing Canadian industry and universities. These initiatives included fairly drastic – by the standards of most academic institutions – measures, such as commercializing some of the School's hiring and other activities, constructing physical facilities for use by groups outside the University, television advertising to promote not only the School's courses but also the mining industry as a career, and inducing the industry to award unusually generous – and, hence, very prestigious – scholarships.

Issues in education were further pursued by a panel discussion among representatives of both academe and industry. Hugh Morris, President and CEO of Imperial Metals, set out clearly the relative responsibilities of employee, employer, industry and educators for the different types of education and training required at all levels of a mining organization. As an experienced practitioner in the field of continuing education for mining professionals, particularly in mineral economics, Brian Mackenzie of the Centre for Resource Studies and Queen's Department of Geological Sciences described the factors and circumstances which he considers necessary for success in this endeavour. Dennis Shannon of Cambrian College discussed the ingredients required to produce a qualified worker, with emphasis on the training of skilled mining trades. Another industry perspective was provided by Noranda Minerals Vice President Klaus Konigsmann, who proposed an innovative system of courses to accommodate people already employed in the industry.

After a luncheon address by the Hon. Hugh O'Neil, Ontario Minister of Northern Development and Mines, in which he emphasized government's willingness to support industry initiatives to cope with the problems under consideration at the seminar, the participants engaged in a fruitful closing discussion. It was universally felt that it should be possible to produce some ideas which would result in definitive follow-up action, rather than the more usual, unproductive, departure from such a session.

Foreword

This volume contains the proceedings of the 20th CRS Policy Discussion Seminar. The CRS seminar series brings together individuals from industry, government, labour, universities, and other organizations to share their knowledge and views on selected issues in mineral policy.

The seminar was held at the Donald Gordon Centre for Continuing Education in Kingston on March 26-28, 1990. The proceedings volume was edited by Moira Jackson and produced by Dorothy Smith and Donna Stover.

The Centre is grateful for the contributions of the speakers and participants, both during the seminar and in preparation of the proceedings. Views expressed are those of individual participants, and do not necessarily represent the views of the Centre or its sponsors.

Margot Wojciechowski
Centre for Resource Studies

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Human Resources in the Canadian Mining Industry Challenges for the Future

Brian Ferguson

In accepting the invitation to participate in this seminar and in particular, to provide the keynote address this evening, I was unclear as to the motives of the Centre for Resource Studies in organizing the seminar. There appears to be a strongly held perception in some quarters that the mining industry in Canada is facing a significant problem in the future availability of human resources. What is not clear is how widely that perception is held or how significant the problem is perceived to be. Judging by the eminence, calibre and broad basis of representation from the industry here this evening, I expect to find out over the next two days.

Encouraged by the organizers of the seminar, the views I am about to express are either my own or those of others that I generally endorse. They do not necessarily represent the policy of the corporation I represent.

If we do agree that we are facing a serious problem in meeting the future human resource needs of our industry over the next decade and beyond, how would we suggest dealing with it? What kind of solutions would be effective and in whose hands must the solutions be implemented? Is it a problem for the mining companies alone or must all the other interested parties represented here be involved in solutions?

I believe that there are some deep-seated problems in our industry that have been around for some time that render our industry a relatively unattractive or unrewarding place to work, or at least render the perception of such.

A graduate in mining from the University of Leeds, Mr. Ferguson has a post-graduate diploma in Operations Research and Management Studies from Imperial College, London. He joined Falconbridge Group in 1964 after working for several mining companies in Canada and Africa. He has worked in various capacities in mining engineering and operations at different operations, including the Sudbury Operations and Falconbridge Dominicana. Mr. Ferguson was appointed President, Kiena Gold Mines Limited, in 1984; President, Corporation Falconbridge Copper, and Director of Mining for Falconbridge Limited in 1986; and Vice President, Mining, in 1988. In addition to these regular responsibilities, he was appointed Chairman, President and Chief Executive Officer of Falconbridge Gold Corporation in 1988.

In recent years, individual mining companies have to a greater or lesser degree recognized this as a fact and have attempted to do something about it with varying degrees of success. Nevertheless, the problems may be serious enough that industry-wide solutions are required and that only co-ordinated industry wide action can bring about significant change.

In Canada, most of us believe in the principles of free enterprise and competition which have served us well in the past. We may feel comfortable that the problems before us today can be resolved by each of the individual companies we represent in our own individual ways. This may be so. However, we must keep in mind that we are now competing in an increasingly global market in which our competitors, particularly in the Third World, do not play the game our way.

In many areas within our industry we have found common cause in the solution of problems. Our national and provincial mining associations foster collaboration in many policy areas, and in our relationships with government. In the area of mine safety we are beginning at last to see meaningful results of collaboration between management and organized labour. Perhaps, in the context of human resources, it is time to discover broad ground and common cause not only between individual enterprises but between what we continue to term as "management and labour."

The Global Economy

That the Canadian mining industry is competing in a global metals market I take almost as a given fact, although I know that there remain many who believe that we should continue to place nationalistic restrictions on the economics of producing metals and minerals in Canada that affect profitability. For those, I refer to the excellent address of Dr. Klaus Zeitler of Metall Mining Corporation which he delivered at the Prospectors and Developers Association Annual Meeting in Toronto two weeks ago. He pointed to the increasing exploration opportunities overseas.

We have heard much in recent years of the notion that mining in North America is a sunset industry. Today, there are those in high places who would discount the long-term value of Canada's resource base in the country's future. Concern has been expressed that the grades of our orebodies are declining, that we have found all the big rich ones, and without new big, high-grade orebodies we will be unable to compete - or so it goes. Perhaps this is the commonly held view that has led to the decline in base metals exploration in recent years and which is now beginning to show signs of revival. The recent improvement in metal prices and important new discoveries has perhaps restored our faith to some extent. The declining grade theory has

been thoroughly disproved by Dr. Brian Mackenzie. Increasing allocation of funds for exploration lies in our own hands, even though the federal government has declined to provide further assistance by way of tax incentives.

What we all believe to be true is that Canada is well-endowed with mineral resources and that these resources will continue to play a major role in our future well-being as a nation. We are constrained by our geography and the standards we impose on ourselves relating to the quality of life; the working environments in our mines and plants and the impact that these plants have on those outside the industry. Beyond that, the true limitations on our ability to compete globally are the availability and quality of our human resources and, in view of their high price, the efficiency with which we determine to employ them. During this address I will put forward a number of objectives or challenges for the industry initiatives that might be followed or are related to making more effective use of our human resources.

The first of these challenges to the industry therefore, is

> "To improve global competitiveness in the production of metals and minerals."

To do this we have to be profitable in the long term by maximizing our key advantages – our natural and human resources.

Much has been said and written about the role of technology and R&D in our endeavours to remain globally competitive, particularly with nations in the Third World. We must now give added consideration to the emerging eastern bloc countries who will be seeking wider entry to the global marketplace. But technology, in itself, is not enough. For one thing, technology becomes available to all, sooner or later.

The key, of course, is human resources. We must retain our advantage through the further development of our educational and training facilities, the sophistication of our management skills, organizational ability and economic know-how. And when we talk of human resources, we must include personnel at all levels and from all areas of our organizations. There are few unskilled jobs in the industry today, only untrained or inexperienced employees.

The Mining Industry in Canada

Turning closer to home then, our ability to develop and maintain a highly competent, educated and skilled workforce depends first on our ability to attract and retain high-calibre employees. In this respect we must compete with other domestic industries for talent. These other industries are most

often located in more populated and better serviced areas of the country. The second challenge for the industry therefore, is

> "To be nationally competitive in attracting high-calibre people to all fields of endeavour within the mining industry."

To do this, we have to provide interesting and rewarding places to work for all throughout industry proper and in industry-related organizations, including the government.

The two principal impediments to this are the northern location of the majority of our mining operations and the cyclical nature of our industry. The difficulties related to living in northern, often remote, locations are well understood, and novel solutions have been devised to modify some of those difficulties. Suffice it to say that they will take on increasing significance in the future. The cyclical nature of our industry is an equally fundamental and sometimes overwhelming problem.

The Cyclical Nature of the Industry

The external economic and market forces that regulate our industry are more or less beyond our control. However, we do have some opportunities as to the way we respond to the onset of periods of both high and low metal prices. These opportunities are to be found in the way we husband our human resources.

The traditional concept of labour (in its broadest sense) as a commodity input to production has been with us since the industrial revolution. The way in which the supply of labour is controlled has developed little over the years. Managements are no longer able to "hire and fire" at will but do resort to temporary layoff that often amounts to the same thing. Permanent workforce reductions are unavoidable in the case of exhaustion of ore reserves or because of a major technological change in market economics. Temporary layoffs however, are likely in the future to become socially unacceptable. They already are in much of Western Europe. During downturns in North America, key staff employees are retained on the payroll to avoid the potential loss of the investment in training, experience and skills involved. But in our increasingly technological industry, differentiation between employee groups becomes less valid. Critical skills are becoming inherent in all parts of the operations and are similarly scarce. A third challenge to the industry therefore, is

"To minimize or eliminate the effect on our people of the impact of demand/production cycles."

To do this we have to stop thinking of people as an expendable commodity and develop more efficient mechanisms for controlling the cost and availability of human resources.

Three mechanisms come to mind:

1. Longer-term planning in the allocation and deployment of resources between production and development.

2. Greater use of contractors and specialized outside services for non-routine work and during periods of abnormally high development activity.

3. Variable pay compensation based on a substantially lower base salary payment with a variable productivity or profit component linked to corporate financial performance and current market economics.

All of these options are in use in other economies and, to a greater or lesser extent, in our own industry. They will be employed increasingly in the future. The third option has been considered as unworkable in Canada's adversarial unionized environment. Profit sharing has not been widely supported as a concept by managements of mining enterprises and almost invariably rejected by organized labour. Nevertheless, the essential logic of the concept will determine its eventual and inevitable application in the industry.

Participative Management and a New Social Contract

Traditionally in Canada, labour unions have accepted little or no responsibility for the economic performance or well-being of the industrial enterprise. It is not surprising, since they were rarely invited to do so. In more recent times, when the industry has found itself in serious financial trouble, it has been different. Even so, union scepticism is hardly surprising.

Participation of labour representatives in the management of enterprises and in at least witnessing and influencing the decision-making process is an established fact in Western Europe and Scandinavia.

In recent years, progress has been made in our industry in what can be loosely termed "participative management". This process has occurred predominantly in newly established non-union operations restrictive practices and constraints to the efficient deployment of human resources usually

embodied in collective agreements are absent. Even in unionized operations, participation of employees in cost management programs has met with much success but continues often to be met with suspicion and rejection as the official union viewpoint. The future economic viability of the industry is a matter of concern to everyone connected with it, so that a fourth challenge must be

> "To develop a "social contract" between owners and employees to produce and maximize lasting benefits to both sides on an established equitable basis."

To do this we have to have a better understanding of how all the parties involved (shareholders, managers, workers, suppliers, financiers and governments) contribute and now share in the results and a consensus of what constitutes a "legitimate" share of the wealth generated. Part of this new contract must involve the development of a radically new approach to work incentives and the distribution and payment of rewards to both organized and unorganized employees. This would have to be counter-balanced by management undertakings to reduce or eliminate the incidence of temporary layoffs.

Incentives

The question of incentives is extremely important. Traditional work incentive schemes persist throughout the industry, either because of the unwillingness of management or employees to change, or to avoid confrontation and the risk of production disruption. But it is becoming unquestionable in my mind that traditional individual or small-group mine bonus systems are outdated, often ineffective and frequently counter-productive in modern mechanized machine-paced operations. Technological development in the mines has even been impeded by such systems so that the full benefits of new methods and technology are not realized. Work incentives, properly applied, are essential to the industry. Group incentives, linked to overall productive performance of a mine or plant, have been successfully introduced into many operations with identifiable benefits. They have shown progressive gains in overall productivity and greater acceptance of change and the introduction of new technology. This question of incentives has much to do with establishing equitable levels of total compensation for all employees. There is presently a great imbalance of rewards in an industry that must come to rely increasingly on planning, technology and the coordination of skills, and less and less on individual effort.

Education and Training

I would now like to turn to the question of education and training and the establishment and maintenance of a highly competent workforce in the industry. In the context of this seminar, this applies to all levels of employees, ranging from highly trained and experienced mine production and maintenance personnel, technicians and technologists of every discipline, engineers and other professionals, scientists and researchers and operations management. This broad range covers at least three separate traditional employee groups between which the lines of demarcation are becoming less distinct.

The training and education regime for the Canadian mining industry must cater to all these occupations. It must include organized programs of continuing education tailored to industry needs in which the industry may have to assume a greater role of financial support. Departments of existing colleges and universities have a role to play here at a time when they are underfunded and under utilized through low enrolment. Undergraduate engineering education and qualifying courses for technicians and technologists are insufficient in the long run in a world of rapidly changing technology. Programs of continuing education and training both at the institutions and on the job will be increasingly required to upgrade skills to higher levels of recognized competency. Interaction between industry and the colleges and universities is necessary to upgrade both practitioners and educators. Interchange of personnel must be actively promoted.

Industry can expect to become subject to increasing regulation in the future which will demand greater accountability on the part of both professional and other qualified staff and employees. In the area of mine safety, the Internal Responsibility System is now becoming established in the industry and recognized by the Ministry of Labour as the realistic approach ensuring adherence to regulations. This Internal Responsibility principle is likely to be extended to all areas of mine industrial practice relating to the working environment. Because of this trend, the industry will have to place greater emphasis on training and qualification in advancement criteria for all employees.

This leads to a fifth challenge:

> "To ensure that there is an adequate supply of trained and qualified people to meet the industry's needs."

To do this, we have to develop cooperative relationships among industry, educators and governments. The creation of Advisory Councils to the various mining educational establishments in Ontario is an accomplished fact arising in part out of the recommendations of the Ross Report. Establishment of the

Provincial Advisory Committee on Mining Education, to play a coordinating role, is a further step in this direction.

Mining as a Business

The operation of a mine or a metallurgical plant is a business like any other. As the industry become technologically more complex in a permanently inflationary economic environment, the simplistic concept of the mine, solely as a provider of raw material for processing, becomes less valid. The development of the modern mine takes place over an extended time period and can consume vast amounts of capital. Mine production processes are becoming highly mechanized, equipment utilization costs (ownership charges as well as operating and maintenance costs) form a large part of production costs, and the opportunities for selectivity in extraction of the ore by bulk methods are lessened. Nevertheless, the mine and what takes place at the mining face continue to determine in large part the overall profitability of the enterprise. The tenor of the ore delivered for processing is the prime determinant in the economic utilization of expensive processing assets. It follows that the quality of economic decision making in mine planning and the decisions made day-to-day by mine operators are increasingly critical to financial success. This leads us to our next challenge:

> "To ensure that new and increasing demands on the talents of people now working in the industry are recognized and met."

To do this we have to upgrade the technical and managerial capability of people at all levels in the organization, both at operations and in head offices. This upgrading, in the end, can be achieved only through the quality of professionalism that the industry commands. Seat-of-the-pants approaches to operations in our industry have become inappropriate and should no longer be acceptable.

The Mining Professional

Much as been said of the fact that the industry is becoming critically short of professional engineers. However, the supply of engineers in all disciplines is already becoming a problem and the industry must compete with other industries for graduates. This poses two separate but ultimately linked considerations:

- recruitment to the mining industry at university before graduation and
- retention in the industry after several years of employment.

Recruitment involves offering meaningful summer employment and a commitment to organized work experience (appropriate training and work exposure) both before and after graduation. This commitment is required industry-wide. The industry's record in recent years has been poor, impeded in part by widespread temporary layoffs of permanent employees. Retention of professionals depends upon providing challenging and varied work assignments of increasing responsibility. Past practice of having a graduate engineer spend years as a production supervisor or filling a purely technical advisory role without authority are equally inappropriate today. The relationship between the mining professional and the practical experienced mine operator-supervisor or superintendent also needs rationalization in many organizations. Increasing regulation by government departments and the provisions of the Professional Engineers Act, which are beginning to invade the mining area, are placing greater legal accountability on the engineer. This heightened role will need to be recognized both in the organization and on the salary scale.

The Role of Government

Finally, I would like to say a few words about the role of government.

It would appear that in the context of the priorities of today's modern egalitarian society - with concern about the environment, human rights, workers' safety, industrial relations, the ownership of natural resources, and other social priorities - industrial corporations and the managements they employ are frequently cast as the villains of the piece. Clearly, in our society, we can never be satisfied with the status quo and must strive always to improve our quality of life. However, it does not necessarily follow that commercial interests accept social change only when it is forced on them. This appears to be a common perception by governments. The mining industry has been in a constant state of change for the past forty years. Progress in the areas of mine safety, human relations and other standards of corporate citizenship are continuously occurring within the industry without threat or coercion. Nevertheless, government departments are not always up to date to new developments and sometimes cling to outmoded concepts of our industry.

The final challenge then, is

"To develop more effective mechanisms of communicating with governments at all levels, to maximize co-operation, promote collaboration and minimize the adversarial aspects of the relationship."

To do this, the mining industry has to be, and has to be perceived as being, concerned with the public good. Public perception is something which cannot be ignored; it is often more important than the truth.

In conclusion, I thank you for listening to me. The views expressed are my own. Some are undoubtedly controversial, even provocative. If I have been overly critical of the industry and its related institutions in not recognizing that many of the things I am suggesting are in fact being done, I apologize to those concerned. Others may feel that some of the issues put forward are irrelevant, overstated or do not have sufficient importance or practicality to concern the industry. I trust that this is not the case.

Skill Mix Among Mining Industry Workers: Trends and Outlook

Edward McDonnell

In approaching the whole area of human resource planning in the mining industry, it soon becomes evident that we are not dealing with generic or interchangeable employees for which it is necessary to determine the industry's future needs. On the contrary, the mining industry involves a highly complex set of activities, drawing on a variety of special skills which are embodied in distinct individuals. To achieve this level of specialization, these individuals must undergo training or education, the cost of which is justified by the increase in productivity which results. The problem for human resource planning then becomes that of ensuring that future requirements for workers in each of these skill categories are met.

This paper, as its title indicates, focuses on the mining industry's skill mix. I will first spend a few moments discussing the importance of the topic. Next, I will highlight some factors which have an impact on the industry's ability to adjust its skill mix smoothly and quickly to changing circumstances. Some of these factors are specific to the mining industry while others are not. Following that, I will examine statistical evidence on the changing occupational profile of the mining industry. I will then look at changes in levels of educational attainment in the industry. Next, I will look at future skill requirements in the mining industry, based on responses to a recent small survey conducted by the Centre for Resource Studies. I will conclude by summarizing the state of our knowledge in this area and by suggesting areas for discussion and for further investigation.

A graduate in Mathematics/Economics from University College, Dublin, Mr. McDonnell also holds master's degrees in Economics from University College and the University of Western Ontario. He has been an economist for the Department of Energy, Mines and Resources in Ottawa since 1986, after several years spent teaching at the College of Commerce, Dublin, and in the departments of economics at the University of Western Ontario and Concordia University.

The importance of skills to the mining industry is, I'm sure, evident to everybody at this seminar. Canada's mining operations must deliver a quality product at a reasonable cost to be internationally competitive and this requires high levels of competence at every stage of the production process. The more closely a mining operation's workforce corresponds to its skill requirements, the better. If skill levels are too low, following routine procedures may be adequate 90 percent of the time but even minor problems can cause production processes to go off-track. Skill levels can also be too high, though that is a situation that is unlikely to arise except, perhaps, when product prices are particularly buoyant and attention to costs is allowed to slip.

The importance of the quality of Canada's workforce is borne out by a recent survey of opinions of business and labour leaders made public by the Canadian Labour Market and Productivity Centre (CLMPC) in January 1990. Both groups of leaders deemed education and training to be the most important factor in improving Canada's competitiveness, ahead of items such as lower government deficits and a lower Canadian dollar. Thirty-five percent of business leaders and 38 percent of labour leaders ranked it first in importance; an additional 25 percent of business leaders and 26 percent of labour leaders ranked it second in importance. The survey, based on 119 responses from business and 72 responses from labour also revealed some preferred approaches to training and skills formation which we can explore in the discussion to follow.

Achieving and maintaining high levels of skills in the workplace is a major challenge. Both employers and employees may, for different reasons, be reluctant to undertake investments in skills. In the case of employees, the major cost of *full-time* education or training is in terms of foregone wages. Younger workers are more prepared to make this sacrifice than those further advanced in the life cycle. The result is that, as workers age, it becomes increasingly difficult for them to improve (and sometimes even to maintain) their skills unless employers facilitate the process through part-time and on-the-job training.

For employers, there is sometimes a reluctance to invest in workers whom they may either lose to other firms or be forced to let go in the event of an economic downturn or the exhaustion of an orebody. Both these factors are significant. Since most skills are transferrable, employer investments in human capital are much more at risk than investments in physical capital. (In this connection, the Canadian Labour Market and Productivity Centre (CLMPC) Survey revealed that 24 percent of business respondents and 29 percent of labour respondents view inter-firm poaching as an important obstacle to training and retraining of Canadian workers.) The desire to avoid investing in assets which may be lost completely at the next cyclical downturn can also result in a reduction in the emphasis on skills development. This is,

Importance of the Issue:
Skill Mix Should be Just Right

Too low: production and quality objectives compromised
Too high: wage costs may be adversely affected

Canadian Labour Market & Productivity Centre Survey:
Most Important Factor in Improving Canadian Competitiveness

	Business	Labour
Training & Education	35%	38%
Lower Government Deficits	16%	0%
Increased R&D	14%	26%

Second Most Important Factor

	Business	Labour
Training & Education	25%	26%
Increased R&D	20%	23%

I'm sure, a major temptation in the mining industry, which is particularly cyclical in nature. Yet, while flexibility may seem to be increased by going to the market only when skilled workers are needed, this flexibility is not without its costs. One is likely to be looking for these skills at a time when they are in high demand generally, with the result that wages may be bid to very high levels. Possibly the search will be fruitless and firms will have to temporarily make do with an underqualified person in the job.

Other factors are important in skills adjustment. The fast pace of technological change increases the rate at which skills become obsolescent. Unless human resource planning accompanies technological changes, this creates a perception of always playing catchup. In the mining industry, the remoteness of many of its operations requires greater innovation in attracting and retaining skilled personnel. On the positive side, an innovative and sensitive approach by mining firms can ensure that important skills are not lost to the mining industry as a result of mines closures. Finally, it is important not to overlook the large and local labour force of women and natives in building a stable, highly skilled workforce.

Key Factors

- Time horizon of employers and employees
- Technological change
- Nature of mining industry
  - cyclical
  - remote
- Turnover/demographics
- Overlooked workforce
  - women
  - natives

Let us now examine the changing occupational composition of the mining industry. Figure 1 shows how the relative importance of various occupations in the metal mining industry has changed between 1970 and 1985. The variable being measured along the vertical axis is the proportion of the industry's workforce accounted for by a given occupation in 1985 divided by the occupation's proportion in 1970. A value of 1 thus indicates that the occupation's share of the workforce has not changed over the period, a value of 2 indicates that the share of this occupation has doubled between 1970 and 1985, and so on. Figure 1 is based on Census data which means, essentially, that it depends on how households described their occupations in Census returns. This might differ from how mining companies would describe their workforce in occupational terms, but the difference is probably slight. In any event, Figure 1 tells an interesting story. The occupations which have fallen most in importance are drilling, materials handling, and ore processing. Those occupations which have gained most are excavating and grading, management and administration, and fabricating and assembling (the bulk of this category in the mining industry is accounted for by mechanics and repairmen). Figure 2 provides the same information for all mining. The experience here has been somewhat similar, though the declines in the relative importance of drilling and of ore processing have been greater. Excavating and grading and management and administration have shown greater relative gains in all mining than in metal mining.

Figure 1. Changes in occupational profile, metal mining, 1970-85

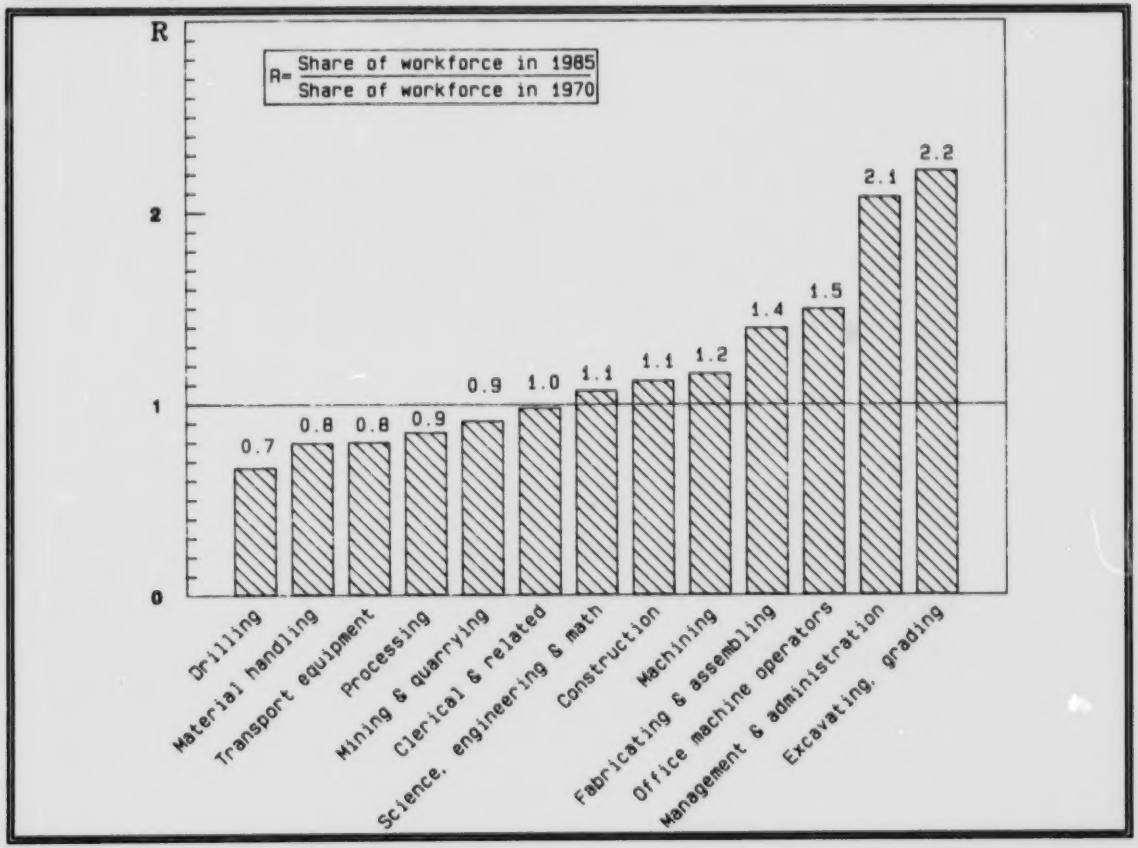
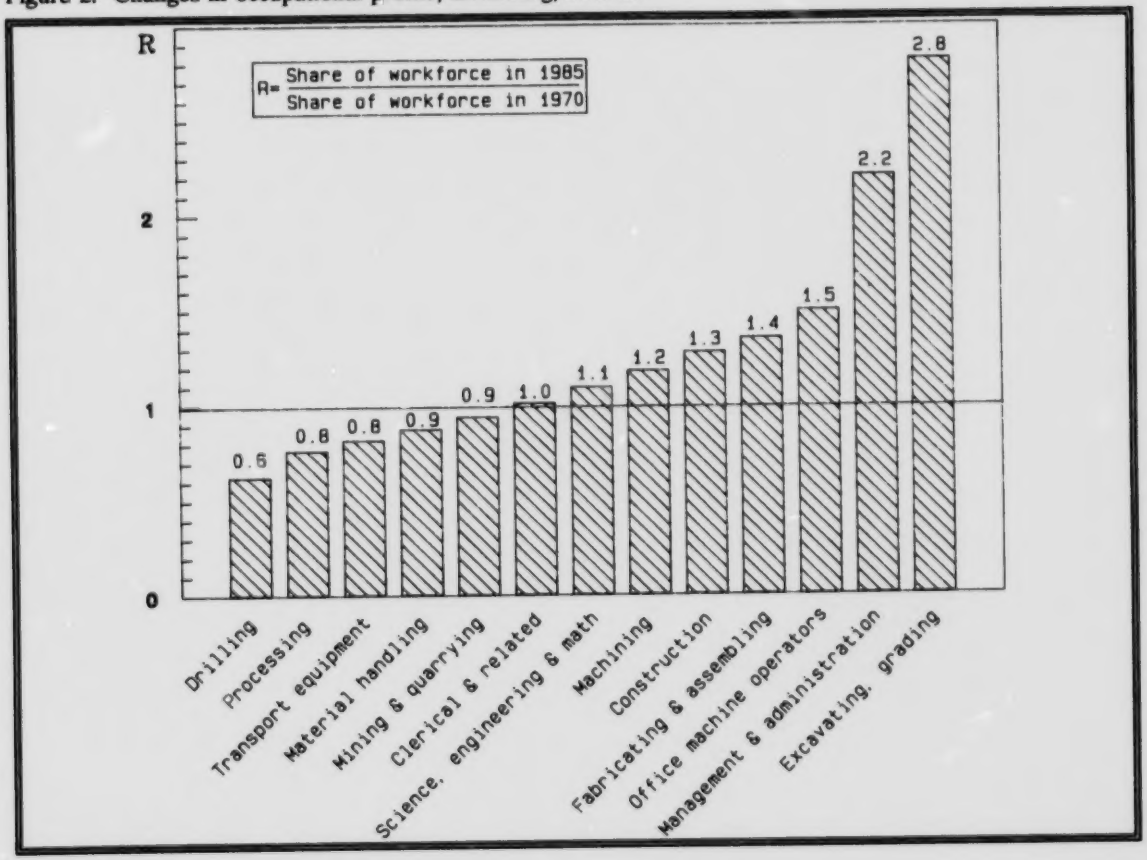


Figure 2. Changes in occupational profile, all mining, 1970-85



The developments which lie behind these figures are, in some cases, neither new nor surprising. Improved drilling technology has reduced the need for those in drilling occupations but has increased the need for equipment maintenance. The increase in the number and proportion of workers engaged in excavation and grading is common to all types of mining but is particularly noticeable in coal mining: the numbers of such workers increased sevenfold in the 1970-85 period while total numbers engaged in coal mining increased by about 52 percent. By 1985, close to 43 percent of those in excavation and grading occupations were engaged in the coal mining industry. This accounts for the significant difference in relative shares as between metal mining and all mining. The increases in the proportions in management and administration are more difficult to explain but may be due to the increasing complexity of the industry.

Figures 1 and 2 highlight changes in the relative importance of different occupational groups. Information on the occupational structure of the mining industry in 1985 is contained in Figure 3. It may be seen that, despite the major changes of the previous decade, so-called blue-collar occupations still accounted for some 80 percent of the jobs in the industry. Actual mining accounted for one job in three.

As well as the major changes in the occupational distribution of workers in the mining industry, there have also been changes in the level of educational attainment. In general, the industry's workforce is now more highly educated than in 1970. This is shown in Table 1 which, unfortunately, is not entirely up to date. (The latest available data on this variable were collected in the 1981 Census.) The table shows the median years of schooling for workers in the broad occupational category of mining and quarrying. This group is perhaps a little too broad for our purposes – it includes mining and milling, quarries and sand pits but also takes in "services incidental to mining" which includes contract drilling of petroleum and natural gas wells. You will recall that the median is an average in the sense that 50 percent of the population lies on either side of the median. From the table you can see that median years of schooling for the occupational group increased by about 1.5 years in the intercensal period. However, median years of schooling in mining and quarrying in 1981 was still lower than that in all occupations though the gap had narrowed somewhat (the figure for all occupations grew from 11.2 years to 12.4 years over the same period). Median education in mining and quarrying was greater than that in primary industries generally (which stood at 10.6 years in 1981). You can also notice from the table that there are significant regional differences in educational levels (with workers in Ontario and the West being better schooled than their counterparts in Quebec and the East), but that these differences became smaller over the decade. There are major gender differences also, though it is probable that much of this may be explained by systematic differences in job types. In any case, female workers

Figure 3. Occupational distribution, all mines, 1985

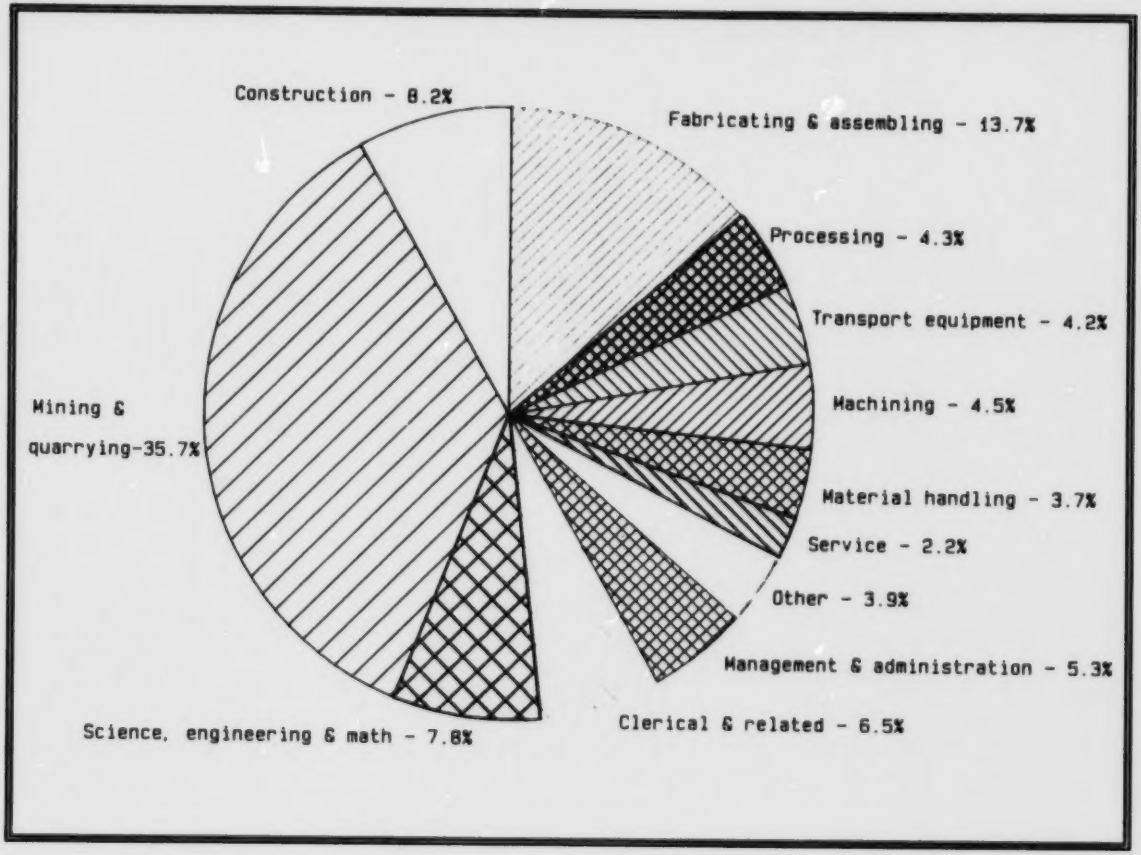


Table 1. Median years of schooling: mining and quarrying

	15 Years and Over					
	Both Sexes		Males		Females	
	1971	1981	1971	1981	1971	1981
Canada	9.5	10.9	9.5	10.9	10.4	12.1
East	8.6	10.3	8.6	10.2	9.6	11.4
Quebec	7.9	10.0	7.9	10.0	8.3	11.1
Ontario	9.5	10.6	9.5	10.6	10.4	11.7
West	10.6	11.6	10.6	11.6	11.2	12.4

	25-44 Years					
	Both Sexes		Males		Females	
	1971	1981	1971	1981	1971	1981
Canada	9.2	11.0	9.2	11.0	9.5	11.3
East	8.6	10.4	8.6	10.4	9.7	11.1
Quebec	7.8	10.5	7.8	10.5	7.4	10.3
Ontario	9.1	10.6	9.1	10.6	9.6	10.2
West	10.3	11.7	10.3	11.7	10.6	12.1

	45-64 Years					
	Both Sexes		Males		Females	
	1971	1981	1971	1981	1971	1981
Canada	8.4	8.8	8.4	8.8	9.7	9.5
East	8.1	8.7	8.1	8.7	-	-
Quebec	6.8	8.4	6.8	7.4	5.5	8.0
Ontario	8.6	8.7	8.6	8.7	8.4	8.5
West	9.1	10.0	9.1	10.0	11.7	11.8

in mining and quarrying have roughly one year more schooling than their male counterparts.

In an effort to fill the information gap which arises from not having corresponding data from the 1986 Census, we might look at Table 2. This gives the percentages of those engaged in selected occupations which have attained five different educational levels. Note that these occupations are not confined to the mining industry though, in certain cases, mining is a major employer. As you can see, educational levels in all occupations in the table have increased significantly. It should be stressed that it is not possible to draw strong conclusions about educational levels in the mining industry on the basis of this information, but it is likely that the industry has a correspondingly better educated workforce.

Years of schooling is an important measure of the skill level of the workforce, but it is not the only one. Much occupational training takes place outside the school system, through apprenticeship programs and on-the-job training. For many mining occupations, this is perhaps more important than formal schooling. Table 3 indicates that, in certain areas of importance to the mining industry, full-time enrolment in registered apprenticeship programs has been either stagnant or falling in recent years. It is to be hoped that the mining industry is aware of these trends and is helping to take up the slack through part-time and other forms of training and skills formation.

We do not have a lot of data on the extent of training/retraining in Canadian industry generally or in the mining industry specifically. Table 4 shows some results of a recent review by Labour Canada of provisions for employer-paid training in major collective agreements. This term designates agreements covering 500 or more employees and covers 65 percent of the unionized workforce. As you can see, the more practical and job-related the training, the more likely employer funding is to be a contractual right. Still, most of the training is being done by the same group of companies, and much less than half of the unionized workforce is covered by such provisions. The mining industry scores best on the first two types of training provisions. Seventeen agreements in the mining industry, covering 24,653 employees, contain provisions for employer-funded on-the-job training and 19 agreements covering 27,141 employees contain provisions for apprenticeship training for trades workers. Examination of individual agreements reveals that the two types of provisions are often found in the same collective agreements.

Table 2. Selected occupations by level of educational attainment, 1980-85 (percent)

	Less Than Grade 9		Some High School		High School Graduate		Some Post Secondary		University Degree	
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
Mining & Quarrying	24.60	18.07	38.62	36.83	15.98	13.04	20.12	29.71	1.24	2.36
Fabricating & Assembling	20.30	16.20	25.92	23.92	13.98	11.56	38.73	46.89	1.06	1.42
Construction	19.46	16.07	24.57	23.64	14.72	11.71	39.94	46.90	1.30	1.68
Excavating, Grading	35.93	28.85	34.97	35.46	12.62	11.98	15.97	22.78	0.50	0.94
Material Handling	28.03	22.64	40.44	46.34	18.95	16.59	11.53	20.85	1.06	1.15
Science, Engineering & Math	1.18	0.81	6.82	4.71	11.90	5.64	35.70	47.02	38.28	41.81
Clerical & Related	4.73	3.33	26.98	21.90	38.26	25.03	26.34	44.76	3.69	4.97
Management & Administration	4.66	3.32	18.53	13.68	23.22	12.98	29.67	43.16	23.92	26.85

Source: Statistics Canada

Table 3. Full-time enrolment in programs for registered apprentices, 1983-84 to 1986-87

	1983-84	1984-85	1985-86	1986-87
Welding Technologies	2,527	2,045	2,039	1,973
Engineering - General	1,114	1,168	1,022	1,039
Engineering - Industrial	7,524	5,692	6,401	5,874
Machinist	4,443	3,690	4,656	4,222
Heavy Equipment Mechanics	9,370	7,727	7,752	7,629

Source: Statistics Canada 81-229.

Table 4. Percentage of agreements and employees with provisions for paid training

Type of Training	Agreements	Employees
On-the-job training	34%	41%
Apprenticeship training	31%	30%
Outside courses	22%	30%
Retraining: tech. change	17%	19%
Education leave (job-related)	15%	19%
Education leave (general)	5%	9%

Source: Labour Canada

Turning from provisions for training/retraining to actual expenditures, the evidence is even more fragmentary. A Statistics Canada Human Resource Training and Development Survey sponsored by Employment and Immigration Canada estimated that firms in private industry spent $1.4 billion on training their employees during the fiscal year 1986-87. (No estimate was produced for the mining industry separately.) To give some perspective, this means that, in the labour force at large, expenditure on training is between $100 and $150 per worker. The survey noted that the subgroup termed "Construction, Wood and Energy", which included mining, accounted for 19 percent of the companies, but only 15 percent of the resources devoted to training. It also found that just under half of the money devoted to training by private firms was expended by some 500 firms with employees in excess of 1,000.

Human Resource Training & Development Survey

Percentage of Companies that Estimate Human Resource Needs in Advance:

- 39% of companies with 100 or more employees
- 31% of companies with 50 - 99 employees
- 23% of companies with 10 - 49 employees
- 22% of companies with 0 - 9 employees

1986-87: $1.4 billion spent on training by private industry in Canada

At the beginning of the year, the Centre for Resource Studies mailed out a questionnaire to some eighteen mining companies. The question asked was, "Do you expect your company's skill requirements for new hirings to increase, decrease or stay the same in the next decade?" and some broad categories of education and training were identified. While the responses reflected somewhat the conditions of individual companies, some common themes were also evident. In general, companies would like to see increased skill levels among mining engineers, heavy equipment operators and management. In the latter category, some respondents commented that environmental management skills are becoming increasingly important in the industry. The questionnaire did not ask what the participants in the survey were doing to meet these human resource needs. I expect this question will be addressed during this seminar.

To conclude, I would like to summarize our knowledge and raise some points for discussion. The statistical evidence supports the point of view that the mining industry is becoming increasingly "high-tech" with sophisticated technologies which require relatively fewer but more highly skilled operators. Maintenance and repair of this equipment have led to an increased need for skilled mechanics and other specialized personnel. In the management area, the increasing complexity of the business environment has led to increases in management personnel. On the training side, we know relatively little about how these changes were accomplished – that is, what combination of training of existing employees and new hires was used? What adjustment problems

were experienced? What have we learned that will help us in our human resource planning for the future (for example, in the areas of mining engineering and environmental management highlighted by the CRS survey)?

Some additional issues relate to the elimination of existing obstacles to training. In addition to inter-firm poaching which I've already mentioned, the CLMPC respondents also found major barriers: no employer facilities, no employer interest and a preference to recruit when new skills are needed. How do we eliminate or reduce these barriers? Survey respondents felt that individual companies and industry as a group should play a larger role in training and retraining. Is this also the case for the mining industry? If so, what kind of role? Significant numbers of respondents broadly approved of provincial responsibility for apprenticeship programs but indicated a desire for some federal standards. Is this important in mining also? Would it result in more use being made of these programs? How can the northern and native labour force be accessed more effectively by the mining industry? Would this necessarily help to stabilize the mining workforce?

I realize there are a lot of questions here. It is a tall order to expect that we will come up with answers to all of them at this conference. I propose that we consider some of them in the discussion to follow.

Human Resource Planning at Inco

Paul W. Parker

For those who may not be familiar with Inco, just a word of background: We are the world's largest producer of nickel and a major producer of copper, cobalt, precious metals, sulphur products and alloys. Our principal operations are based in Sudbury, Ontario; Thompson, Manitoba; Indonesia; Clydach in Wales; and Huntington in West Virginia.

For the most part, I will be talking about the Ontario Division, which is the heart of our operations, employing about 8,000 people in the Sudbury Region. We are currently operating ten mines, three concentrators, a smelter and three refineries in this division.

Human resources and human resource planning play an increasingly important role in all our lives. Other important issues such as environment, safety, productivity and cost-competitiveness of our mining industry are attainable only through the proper utilization of our human resources and today the challenge is greater than ever before to have the right people doing the right thing.

For many years, our hiring practices for professional, technical, maintenance, and operating people were basically the same. Recruitment tended to follow the nickel market. When times were good, we had our managers and employment people visit the campuses of our major universities and colleges and recruit what we thought was an appropriate number of graduates. We were greatly assisted by the infrastructure in and around the Sudbury area servicing a regional population that currently numbers about 150,000 people.

Mr. Parker is a mining engineering graduate of the University of Toronto. After a year at Stanleigh Mine in Elliot Lake, he joined Inco in Sudbury, where he has held positions of increasing responsibility in line management. Besides various safety- and production-related positions in the Mining areas, he has been Acting Vice President (Manitoba Division), responsible for milling, smelting and refining, and Assistant Vice President, Mining and Milling (Ontario Division). He is presently Vice President of Administration, Engineering and Maintenance. In addition to his duties at Inco, Mr. Parker is Chairman of the Board, Mining Industry Research Organization of Canada, a Director of both MITEC and the Canadian Mineral Industry Education Foundation, and a past member of the Advisory Council on Mining Engineering at Queen's University.

This tended to offset the negative influence of size and opportunity for the new graduate in joining a large company. We ensured our salaries were competitive and selected mainly from the middle to top third of the class. We always tended to meet or exceed our requirements, and attrition was not a serious problem. A variety of on-the-job training for the new grad was tried, but follow-through was at best haphazard and short-lived.

Our requirements for tradespeople were almost entirely met through on-the-job training of apprentices selected from operating ranks. Apprenticeships involved rotation through the mines and plants to gain exposure to all our operations, and this was combined with appropriate classroom training certified by government. Operators, including miners, were hired on the basis of their health, size, work experience and a brief interview by our employment people or occasionally by an operating superintendent or general foreman. Turnover was high, but there always seemed to be a sufficient number of strong, healthy applicants.

This pattern continued through until the mid-1970s when Inco's fortunes in the nickel industry started to turn with increased competition, lower prices and accumulating inventories of unsold product.

The 1980s became a decade for survival. A workforce of 23,000 in 1971 in the Sudbury area was reduced through attrition and layoffs to 14,000 in 1982. Since that time, further attrition boosted by three early voluntary incentive retirement programs has reduced our numbers to 8,000. Our production levels were fixed to the current rate by SO_2 emission control orders; in fact, our $500-million smelter revision program to be completed in 1993 will only permit us to maintain, and not increase, our production.

Along with experienced tradesmen and miners, we lost a lot of professional and technical expertise from retirements during this period. Major improvements in technology and productivity were underway at this same time to retain our position in the marketplace.

In April 1988, we resumed hiring for the first time since 1977. Our youngest employee had over 12 years' service and the average age of our workforce was over 46.5 years. The average age of our staff employees was only slightly less.

Before we went out into the marketplace for new employees, we made several decisions with respect to our hiring and training practices:

- we would no longer use application forms - written resumes would be requested;
- while we were looking for experienced tradesmen and miners at the outset, we required them to have a Grade 12 certificate or equivalent;
- all applicants had to write a general aptitude or GATB test. Requirements were strictly adhered to;

- miners and tradesmen were given a skills test where they had to demonstrate their stated skills level to the satisfaction of our training instructors;
- all applicants were interviewed by senior supervision;
- all applicants were required to pass a rigorous medical according to the job requirements.

We had 2,500 applications for the initial requirement of 150 jobs, and since that time have hired over 400 new hourly employees.

Hiring of graduates and technician/technologists has kept pace with the hourly rate experience; in fact, it has exceeded the former ratio as we bring along more technically trained people to deal with the increasing complexity of our equipment and processes. We have hired over 130 engineers and 80 technicians and technologists in the past four years, with skills ranging from mining and metallurgical engineering to computer sciences, business and, of course, the liberal arts. We are tremendously pleased with the ability and performance of these young people.

In 1989, to accommodate the newer employee and to keep our existing employees up to date with the advances in technology, we completely restructured and rebuilt our training department. It is responsible for all training of unit and staff employees, including supervisors. (New supervisors in our mines get six months' intensive training in our underground training area before assuming their job at a producing mine.) A complete training-needs assessment has been undertaken with our staff, and modularized training programs are now being developed to assist in training, career development and succession planning. This system was developed with input from all levels of staff and includes peer review and contributory review.

A recent thrust in the recruitment area has been to develop a joint program with our local community college, Cambrian College, for a certificate program in mining and mineral dressing. It is open to Grade 12 graduates and consists of 16 weeks' education, a 16-week work term and a further 16 weeks' education at the College. The educational curriculum contains courses in basic mining and mineral dressing, terminology, chemistry, English, math and physical fitness. The work term of 16 weeks will give us an opportunity for on-the-job training and assessment. The input is controlled quarterly and there are no guarantees of permanent employment.

In June 1990, the first group of students begin their on-the-job training. We anticipate hiring about 45 to 50 students for this 16-week period. We anticipate resuming with a second group in September. We have made a commitment to this program and believe that the results will more than meet our expectations. We invite other members of the industry to participate in such a program and are prepared to share our experience.

Addressing Future Mining Industry Education Needs

Noël Billette

During the last fifty years, Canadian underground mining has undergone three major technology revolutions. The first resulted from the introduction of compressed air as an energy source and the second from the introduction of diesel as an energy source. The third revolution, which is underway, concerns the expanding use of mine automation and electricity as a primary energy source. Until the mid-1970s, it was relatively easy for professionals, through technical meetings and publications, to keep abreast of the latest developments affecting their areas of technical interest and responsibility. The widespread availability of computers in the industry, especially PCs and laptops has considerably modified the picture. Not bad for a "conservative" industry!

During this period, there have also been extensive changes in the industry's salary structure. Today, miners can earn salaries twice those of engineers, or better. As a result, it is more and more difficult for engineers to implement technology innovations in the mining environment, because of loss of credibility in a free-enterprise context where worth is measured in terms of remuneration. Why should miners lose precious bonus time to listen to less-well-paid engineers? Why should a worker lose time and money introducing or testing proposed new technologies to benefit someone else?

In such an environment, engineers tend to lose interest in fully exploiting their professional capacities, concentrate on supervisory functions, and put less emphasis on further development of their technical capability. After a few

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Dr. Billette received his D.A.Sc. designation from l'Ecole Polytechnique de Montréal in mining engineering, mine systems optimization. He taught for five years in the Mines and Metallurgy Department at Laval University, with responsibility for mine hygiene and ventilation, open pit mining, ore reserve estimation and mine optimization. He also carried out and directed research in the fields of mine safety and bonus, computerized ventilation network analysis based on pressure surveys and underground mine capacity. At the Canada Centre for Mineral and Energy Technology (CANMET) since 1984, Dr. Billette has been conducting research in open pit transportation, blending of ores and computerized mine design. He is presently serving as Chairman of the CIM Committee for Education.

years, most technical skills are lost. Why should somebody spend evenings to maintain or upgrade his or her technical skills when the message the organization is conveying is one of minimal interest in and support of technology? Changes have been so fast and numerous that it is difficult for industry to realize their full implications. Some organizations, however, have taken measures to correct this situation; as examples, Inco has created a research mine; Noranda has introduced a mining division at its Technology Centre; Cominco has disassociated Cominco Engineering Services from operations.

It certainly is not in the best interest of Canada to see the development of two technologically quite different mining industries, one high-tech and one low-tech. If that happens, it will certainly impede movement within the industry and lead to career limitations. For that reason, new technology, once proven effective, must be widely disseminated on a regional basis.

The Canadian Institute of Mining, Metallurgy and Petroleum (CIM) is presently taking action to support and enhance members' technical skills. A CIM ad-hoc committee has recommended the creation of a Membership Development Officer position at CIM headquarters; the officer's responsibility would be to coordinate technical courses to be given by knowledgeable persons across Canada through use of the CIM Branch structure. The appointees to the aforementioned position should be known by May and announced at the 1990 Annual General Meeting in Ottawa.

Some of the functions of the position will include maintenance of relevant course material for various industrial sectors and contacts with branches to define evolving needs and interests. The CIM Committee for Education will review material available and its suitability to meet expressed industry needs. The officer will have the responsibility of scheduling appropriate courses at the Branch level, and their rotation over time.

It is expected that companies and their technical staff will both contribute financially to this effort by CIM to make new knowledge and training more accessible on a regional basis. Company contributions can be viewed as a bonus to employees that will benefit their operations over time. Courses given on a regional basis will permit training four or five persons at the cost of training one person in a southern Canadian city.

The View from Western Canada

George W. Poling

I'm going to give you a little bit of a Western perspective and hope to be a little provocative. As Figure 1 indicates, the industry in B.C. is a very significant industry. You see both large and small operations and mines. Those sand and gravel pits present a dichotomy in the sense that they are not really controlled by the mines ministry. They come under Ministry of Lands and most of those operators are very annoyed at having to answer to two ministries. They answer to a mines inspector who comes and tells them, "you're operating on too high a wall and you shouldn't mine that way", and then they also answer to the lands ministry. The most important aspect of Figure 1 is the number of active exploration sites; having over 1300 there marks us well for the future. In other words, the industry in B.C. is not stagnant but there are a lot of things coming off line. Many of those are smaller gold mines, and we do see two kinds of mining: the large-scale mechanized and the smaller-scale mines.

Figure 1. Size and Scope of Industry

34	Large operating mines
33	Small operating mines
2,000	Sand and gravel pits
42	Quarries
850	Placer mines
1,300	Active exploration sites

Professor Poling received his degree in mining and metallurgical engineering and his doctorate in mineral process engineering from the University of Alberta. On graduation, he spent five years as Senior Metallurgical Engineer at Texaco Inc. in Beacon, N.Y., then joined the Department of Mining and Mineral Process Engineering at the University of British Columbia, serving for eight years as Department Head. He also spent 1975-76 in Johannesburg, RSA, as a research professor at Mintek. At present, he is spending a sabbatical as Coordinator of Applied Research for the Mining Association of British Columbia. His research specialties are the theory and technology of froth flotation, solid-liquid separation, recovery of precious metals, bulk materials handling of solids and slurries, kinetics/thermodynamics of acid generation in mine waste, and environmental protection in mining and milling, and he is the author of over 60 scientific publications and patents.

As Figure 2 shows, the mines are spread throughout the province. The so-called Golden Triangle in B.C. is in the northwest now. That requires an enormous amount of infrastructure. At the moment, governments are very reluctant to invest in the industry, so that infrastructure is not forthcoming – not easily, anyway. The map shows only the major commodities, of course.

Figure 3 shows that in 1988, the latest major review year, mining was the second biggest industry in that province. Their gross revenues were $3.9 billion. The earnings picture in Figure 4 clearly indicates the cyclicality; those are cycles most of us don't like to see. The cycle on the far right shows earnings that amount to a 14 percent return, which is simply not enough to attract investment.

What does all this imply? The Mining Association of B.C. was interested in public opinion and commissioned Marktrend Marketing Research Inc. to produce a report, *Attitudes to Mining in British Columbia*. (The conclusions from the report are reproduced in Appendix I.) It was presented April 14, 1989, and indicated that we do have problems in the labour field. This survey included 663 interviews, and it shows what the people of B.C. think about the industry. They judge it to be important and they actually think we use high technology reasonably well; a very slim majority feel that the industry is performing well. The survey indicates that concern is growing over the environment and that we definitely fall below 50 percent in terms of how well we do. So there is a broadening base calling for better protection for water and better land reclamation. That was a key issue. There is strong support for expansion in mining so we need more people. There was even a three-to-one support for exploration, which was somewhat surprising, although they were not too keen on us exploring or mining in parks: only one in five supported that. They believe the government has to be heavily involved in the industry in terms of regulation, particularly in environmental protection, and most of the public admitted that they don't know much about our industry.

That is some of the background to the question of what to do about delivering education. Figure 5 is a graph that presents a frightening picture. In a sense, it tells me we don't need jobs as much as we need metals and mineral resources. We tend to emphasize that what we do as an industry is generate jobs, but we really don't: we generate resources, and we need those resources. The graph is perhaps a bit of an exaggeration. It comes from a presentation that Suboloff made to the CIM Conference in Vancouver a few years ago. But these people, or their babies, or the eggs for these people are sort of in the pipe already. This is why I believe strongly that this whole notion of sustainable development has to be supported by our industry to preempt those who say that we cannot sustain development, that there are real limits to growth.

Figure 2. Location of participating mines in production in 1988

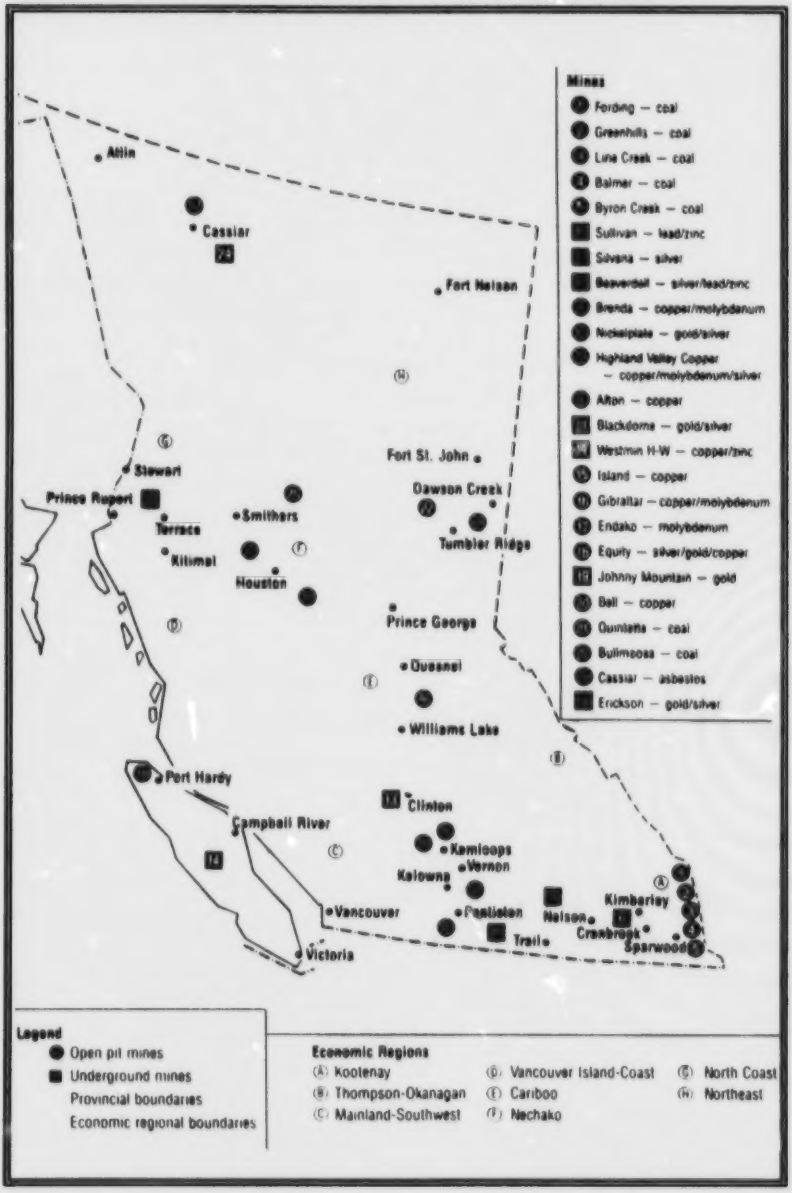


Figure 3. B.C. mining industry revenue by commodity

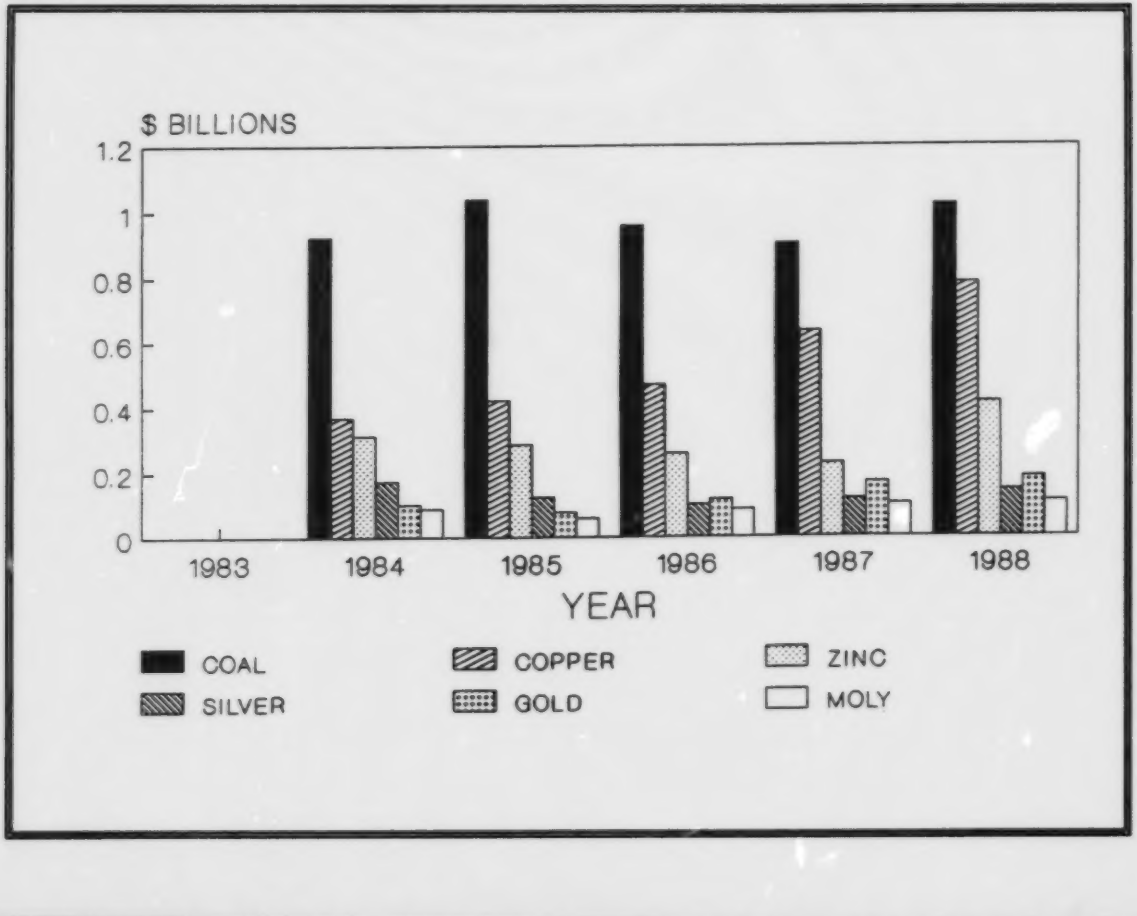


Figure 4. B.C. mining industry earnings

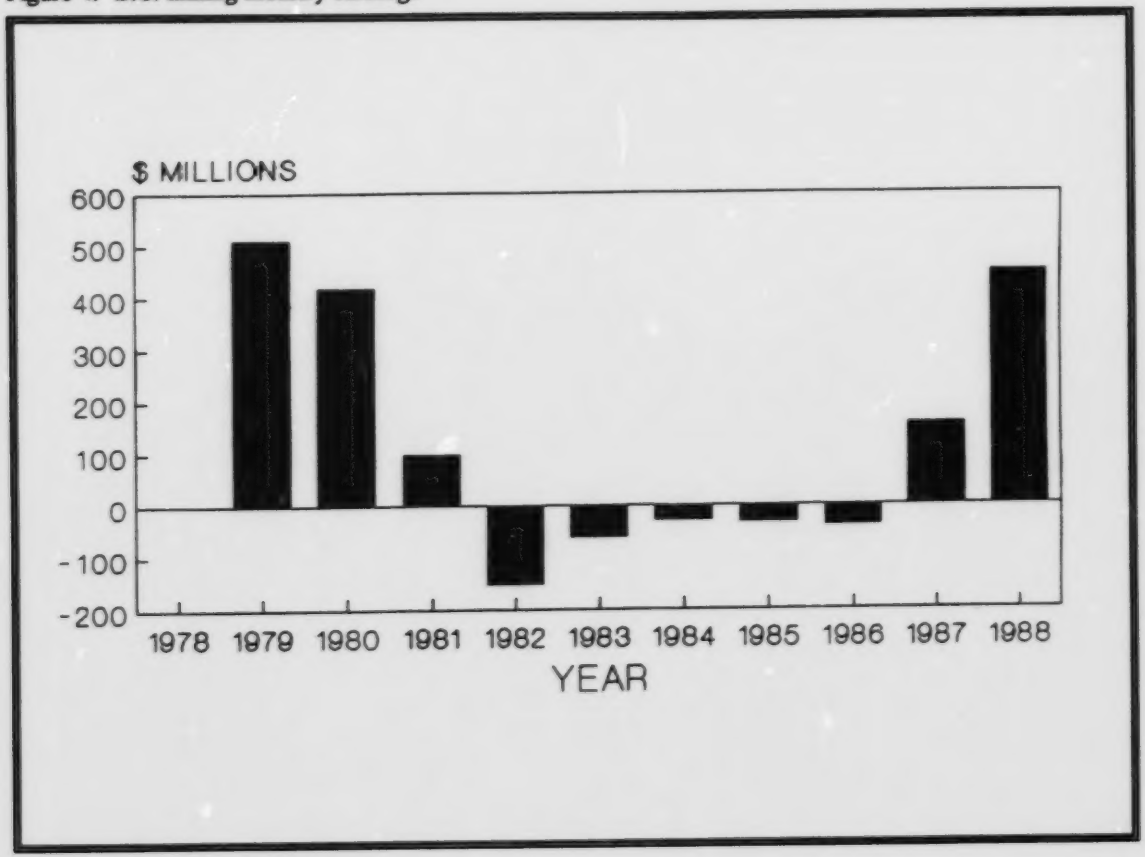
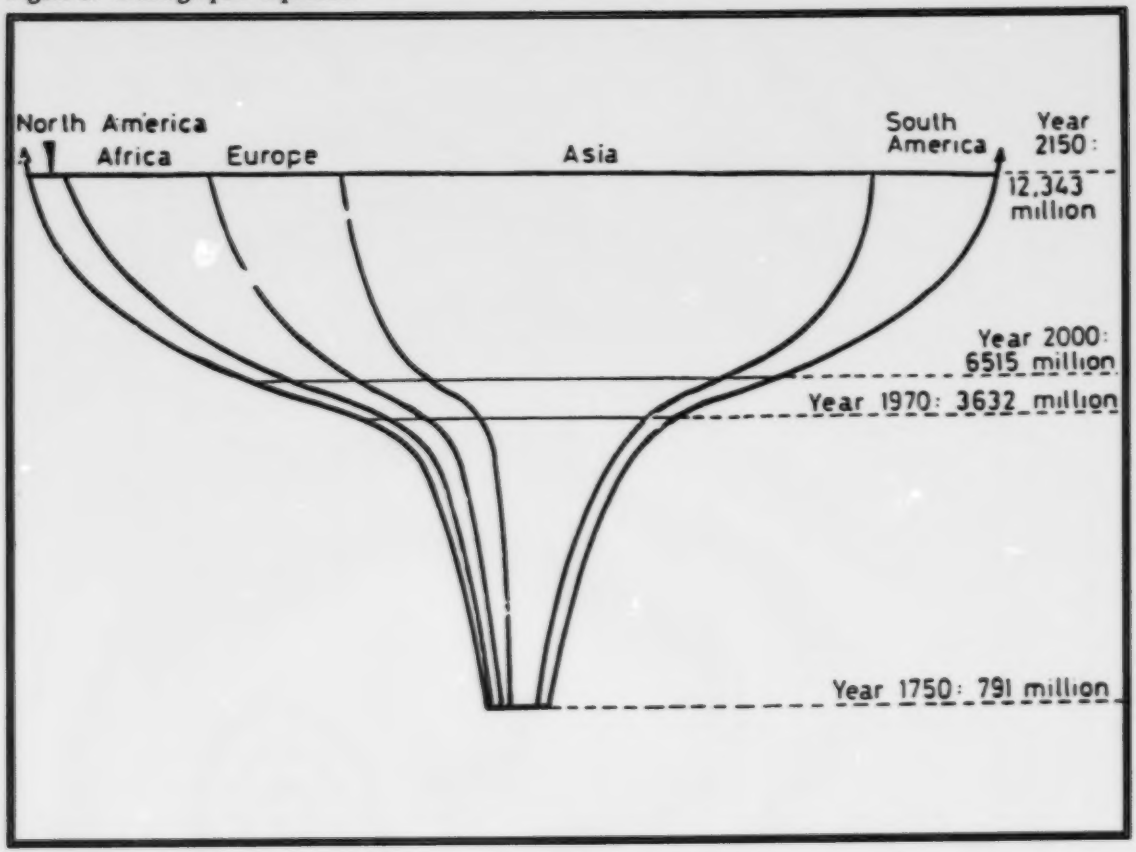


Figure 5. Demographic explosion



But in, say, Eastern Europe the trend is to both democracy and a desire for a higher standard of living and so we're going to have to distribute our resources better. We're going to need a lot more resources and our industry is therefore going to be more and more crucial over the next few decades. The graph gives projections to 2150. I hope we don't expand as far as that shows but it is clear that the resources will be needed, which implies that providing engineers to the mining industry will be supercritical.

Figure 6 comes from *Faith in the City*, the 1985 Report of the Archbishop of Canterbury Commission in England. It was projected to 1990 by Allan Hall in the mining department of U.B.C. The right-hand column shows what's happening through the needs for education or for people's employment data. The only industry there that shows any major increase is services, and of course that's a large number, so that 145 percent increase from 1954 to 1990 is very significant. Mining, not surprisingly, has dropped to a much lower significance in employment. I would suggest that this is a shift of people who would have been categorized as mining to the services category: those people still serve the mining industry. And even if you look at engineering there at 73 percent of the 1954 level, many of those contribute to mining. So it isn't as bad as it first appears.

Figure 6. U.K. employment data
Source: Faith in the City, Report of Archbishop of Canterbury Commission 1985

Industry Group:	1954 Level (thousands)	1990 Level	1990,% of 1954
Agriculture	1227	538	43.8
Mining	868	251	28.9
Food & drink	747	552	73.9
Chemicals	448	370	82.6
Metals	581	241	41.5
Engineering	3269	2372	72.6
Textiles & clothing	1664	470	28.2
Services	7690	11195	145.6
	23468	24123	102.8

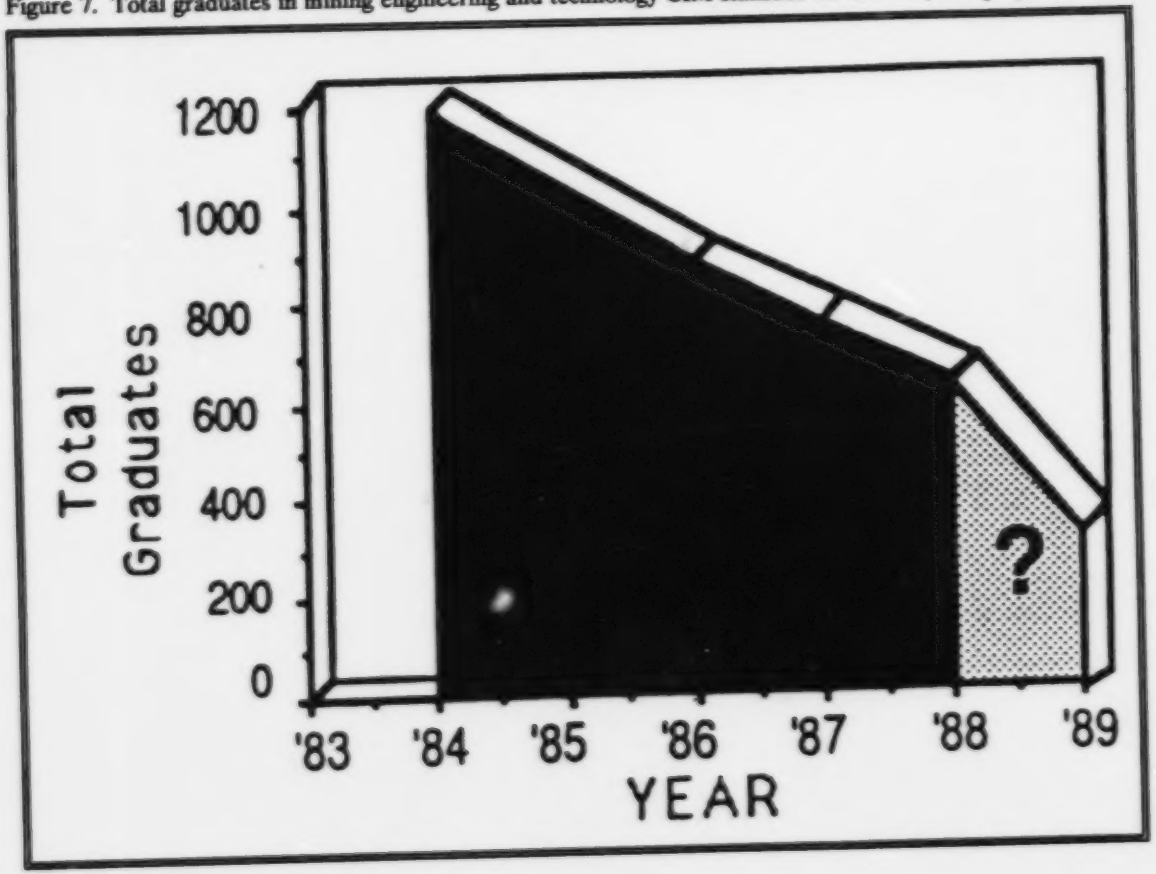
However, the graph in Figure 7 is frightening. This drastic decline in enrolment is what I'd mainly like to address. The question is why is it happening? and how do we combat it? Actually, the trend for all engineering is a bit frightening. One way we combat it is by encouraging woman to enter the profession. We're starting to see a lot of really good contributors among women in mining engineering and I think this really is fertile ground.

We have to do better at delivering education. My perspective is from the West, and it may apply to the East as well, but I think we need to consolidate our resources. At the moment we have only two universities west of Ontario that contribute to mining and process engineering – at University of Alberta in Edmonton and U.B.C. While U.B.C. seems reasonably secure right now, despite the cyclical shifts, I understand next year that University of Alberta is going to discontinue its process option in mineral engineering. U.B.C. is starting to work together with University of Alberta. We have proposals to generate chairs in surface mining. These proposals are quite strongly supported by Mitec, and we have an industry advisory committee that is trying to promote the chairs. Perhaps the two universities out West should look more to becoming universities of the West. We should look too, in fact, to take on some of the responsibilities for looking after the interests of mining in Manitoba, Saskatchewan, the Northwest Territories, and Yukon, as well as Alberta and B.C. Those provincial governments might even provide some administrative support. And perhaps we should also consolidate some of our technician training with colleges and universities. Obviously we have to get more involved in distance education. We're trying to do that by getting more short courses and workshops, adding continuing education for engineers.

The whole environmental question is very important. Not only is it important to protect the environment. The rate of access to land for mining is being adversely affected by our poor image there. A new chair in mining and the environment, the Cominco Chair, is being established at U.B.C., partly funded by some lottery money. Environment Canada seemed to be interested in supporting that endeavour and expanding it so there might actually be two or three or four people in this field of mining and the environment, the problems in acid drainage, cyanides and so on.

We certainly need more specialities in managerial skills for the environment because we need to interact with the public better. The public are demanding input earlier and we must have people who can really express themselves well, not only to other engineers but to the public and to the press.

Figure 7. Total graduates in mining engineering and technology CIM statistics for 1984-87, and projected 1988



Finally, as Canadians, we must have a policy for the economy: we have to become far more aggressive instead of pessimistic. When we look to what we need to do in education, we could perhaps build on those four pillars: we need a self-help attitude on the part of management, a more highly skilled workforce, the consolidation of new technology transfer and a public policy environment designed to promote better performance. If the mining industry aims to bring that aggressive economy to fruition, that perspective will in fact govern our input into educational needs.

The Public Image of Mining: Does It Pose Problems to the Future of the Industry?

William F. Bawden

Natural-resource-based industries, including mining, petroleum, forestry, fishing and farming, have traditionally formed and continue to form the backbone of the Canadian economy. Although these industries are based on the exploitation of natural resources, their image with the general public varies considerably, particularly in Canada. The public image of an industry may be generated in a number of different ways, including exposure to and experience with the industry, media presentation of the industry, education, public relations efforts by the industry, etc. While the general public is not necessarily well informed about any of the industries described above, the industry image resident in the collective public mind can affect factors that may strongly influence those industries.

Let us compare the general public image of two of the more closely related resource industries: petroleum versus mining.

- Petroleum: I would suggest that the existing public image of the petroleum industry is that of a strong, wealthy industry run by rugged entrepreneurs who have built multinational conglomerates based on a calculated combination of risk and the application of sophisticated, advanced technologies as part of normal operations. Although petroleum prices have not been favourable for exploration in Canada for a number of years, I do not believe that the public image of the industry has particularly suffered.

Professor Bawden has held the Chair in Mine Design in the Queen's University Department of Mining Engineering for the past two years. After a degree in engineering geology at Queen's and a master's in geology from the University of Illinois, he received his doctorate in civil engineering from the University of Toronto. He has over 13 years of professional experience in applied geomechanics in the fields of civil, petroleum and mining engineering. He came to Queen's after five years as head of the geomechanics department (Mining Technology Division) at Centre de Recherche Noranda Inc., where he directed a team of professional research engineers and technologists in the development of practical mine design technology for Noranda Group operations.

- Mining: I would suggest that the general existing public image of the extractive mineral industry, on the other hand, is one of a low-technology, very labour-intensive industry where the workforce is subject to inhospitable and often dangerous working conditions. Although the industry has recovered very well from the serious recession of the early 1980s, it is still viewed by many in North America, although not necessarily by opinion- makers, as a "sunset smokestack" industry.

The dichotomy in public image described above for two relatively closely related resource industries is striking. An industry's public image can affect it in a number of ways. One way is that public image tends to focus public opinion which ultimately is expressed in opinion polls. Such polls are one of the major factors influencing federal and provincial political directions and policies. Another way in which the public image of an industry may affect it is in its ability to attract top-quality employees at both the blue-collar and white-collar levels. The very low esteem in which mining is held in Canada is perhaps best summarized in a recent poll published in *The Globe and Mail*. In this survey of pre-university students, the two least popular career options listed were mining and agriculture, two of the most important industries in Canada.

The Image of Mining

As most people in this seminar will be aware, the Canadian minerals industry represents about 5 percent of the Canadian GDP, is Canada's largest export-earner (about 14 percent), and directly accounts for over 100,000 jobs in Canada. With such impressive economic statistics, we must ask how the industry has managed to achieve such a singularly poor image. I believe that part of the industry's image problem is that it is viewed as a very dangerous workplace since most serious accidents and almost all fatalities receive extensive press coverage relative to most other industries. Additionally, the "sunset" label attached to the industry less than ten years ago by Canadian bureaucrats and politicians of the day has left a lasting stigma. This is closely related to the public perception that all metals are prone to replacement by new "high technology" synthetic materials. Much of this perception results from the obvious replacement of metals in automobiles and other consumer goods by plastics.

The Image of Mining People

I believe that the public image of mining people is dominated by two stereotypes:

- One is the image of the "miner", generally pictured in the public mind as simple, strong-backed individuals labouring in remote areas, in an inhospitable and often dangerous environment. While this image may for some be romantic, it is, as a lifestyle, attractive to very few.

- The second image is that of the "mining promoter". For most of the general public this is a negative image tainted by assumed dishonesty and windfall profits.

The Image of the Workplace

Two images dominate the public perception of the mining workplace. In the case of surface mining, the pits are generally viewed as scars that permanently blight the environment. In the case of underground mining, the perceptions are, I believe, different. Most people have never visited an underground operation and naturally have negative visions of this environment. It is visualized by most people to be a remote, dark, dirty and hostile environment. Reports of industrially related diseases such as silicosis and of accidents due to collapse, rock bursts, etc., have resulted in these images. The intense press coverage associated with any mining accident today helps to reinforce this image.

The Image of Mining Engineering

The image of mining engineering in academia is at least as negative as is the industrial image as a whole to the general public. Most universities are not located in or near mining communities. As well, most students are not from mining families and those who are very often now opt for non-mining careers. Thus most university people (staff and students) have no background in or knowledge of mining and hence have the same image of the industry as the general public.

Until very recently both the mining industry and, to a degree, mining engineering were relatively "low technology". This image has not changed significantly. A common perception within the university student body is that the mining student body is composed primarily of people unable to succeed in other engineering disciplines. Additionally, the prospect of living in remote northern sites is not attractive to many young students who see themselves working in "high technology" areas in major population centres. Furthermore, the job potential for spouses and the education opportunities for children are increasingly turning-point issues for many people.

The cyclical nature of the industry has also had a negative impact on its image in academia. This was exacerbated in the serious recession of the early 1980s when the industry simply froze the hiring of new graduates for a couple of years. Word of this, of course, spread very rapidly through the student body. While the economic fortunes of the industry have recovered very well from this period, undergraduate student numbers have not.

Is the Public Image of Mining Justified?

I have presented a very negative public image of the mining industry, and this obliges us to ask whether this image is justified. In general, I believe that the public image of mining is seriously flawed in a number of areas as discussed below.

- The mining image as a low-technology industry is seriously in error and continues to change rapidly. Many people would say that mining is already a high-technology industry. My personal opinion is that it is, at the least, well on the way and is continuing to evolve rapidly in this area.

- Replacement of metals by synthetic materials is a problem. It is also, however, one of the key factors driving the industry into high-technology applications. Technology is being applied very successfully in the development of new metal products (e.g. composites, powder metallurgy and high-technology alloys), and in new, more productive and more competitive mining practices. It is factors such as these that do now and will in future continue to guarantee a market for our metal products. This competitive aspect of the marketplace lies at the core of free-market efficiency and productivity. For this reason I believe that there is no alternative route forward for our industry other than to continue to apply new, advanced technologies at the working face as rapidly as possible.

- Another area of mining that has changed considerably and continues to change is the concept of "remote and isolated" locations. While the majority of new mines are located in remote parts of the country, several factors have combined to alter the implications of this to the industry. Most importantly, modern communications and air travel have altered the meaning of "isolated site". The latest technology, news, etc., are now instantly available.

In addition to vastly improved communications and travel, the industry is no longer, in general, able to, nor finds it desirable to, open new town sites

at the location of new mineral discoveries. The result is that at many new mines families remain in larger established centres while the company personnel "fly in" for various periods. While this solves some problems, such as career problems for some spouses and the problems associated with closing towns at the end of mine life, it also creates other problems.

Potential Human Resource Problems in "High Tech" Mining

Two potential problem areas appear, in my opinion, to require serious attention by the industry if its move toward high technology is to ultimately succeed. The first problem that I would like to address deals with the mining "blue-collar" workforce. At present the mining workforce is, to a large degree, poorly educated. Many people receive site training in order to operate equipment, etc., while others take short industrial courses in order to receive blasting tickets, etc.

In future, however, mines are more likely to require a much higher level of training and education as equipment automation and robotics technologies become more common in the workplace. The "miner" of the future could easily be much more representative of today's "technician".

Question: What, if anything, is being done now by the industry to prepare for the scenario described above? Where will such a specialized and highly trained workforce come from?

The second fundamental problem area that I predict is with the mining engineering personnel. As mining shifts from a low-technology area dominated by the engineering generalist to a high-technology practice dominated by specialist engineering disciplines, the industry must find a way in which to attract and reward suitable people. Today industry management is dominated by personnel taken from the production stream or the financial stream. Mine engineering, in most companies, is secondary to production. This in itself results in a number of problems.

In future, however, the industry must expect to become more and more reliant on technically oriented engineering personnel who, by the way, must have the capability to work with people. In fact, production itself must rely almost entirely on such personnel. The question is, then, how the industry expects to attract and keep such people. As a case in point, let us look at the status of the few "technical specialist" categories that presently exist within the industry. The area of this type that I am most familiar with is the "rock mechanics/ground control" area. The position of "ground control" engineer in mining has traditionally been a dead-end career option considered a "specialist" position. This position, in most companies, was not integrated into the general mining career advancement path. There are a number of reasons

why this may have occurred. It takes a long time for an individual to gain sufficient experience to be effective in the position. Once someone becomes effective, it is quite natural to want to keep him at that position. The result, unfortunately, is that often the individual perceives himself to have stagnated, becomes frustrated and finally quits.

Ideally, ground control/rock mechanics should be part of mine planning, since this is where rock mechanics principles are used most effectively. These individuals should then logically be on the career path to chief engineer, superintendent and mine manager. Most operations, however, are not structured this way. Today rock mechanics personnel represent some of the best technical engineers in the industry and I am continually reminded by industry representatives that we are chronically short of suitably trained rock engineering personnel. Yet, at the same time, many of these personnel are driven from the industry after reaching the conclusion that there is no future except in production. For those not interested in following this as a career path, the options are limited and obvious.

All this makes it very difficult to persuade young people to go into mining rock mechanics since it well may not be their best long-term career option. This basic thought has been expressed to me many times both by people in the business of training personnel and by people in the industry.

Summary

In summary, I believe that the public images of mining as a career and of mining engineering are both very negative. While I do not believe that such images are justified by the facts, these images nevertheless persist. I believe that not only can such negative images lead to possible future problems, but in fact are causing serious problems now. Our inability to attract sufficient high-quality students into our mining engineering programs, for example, suggests a future chronic shortage of appropriately trained engineering talent exactly at the moment when the industry will most desperately need it. Without sufficient enrolment, some existing mining education programs will almost certainly be eliminated as post-secondary budgets are placed under ever tighter constraints. This will then tend to further accelerate the problem.

Only the industry itself can change the situation that I have described. The only remaining question is whether it has the will and foresight to do so.

Thoughts on Multiskilling

Thomas Reid

As someone who has some background in mining and who now works full-time on job-evaluation programs for my Union, I confront the issue of multiskilling frequently. And my first point must be to emphasize that multiskilling is *not* an issue in itself, but several, and that it relates in turn to several other issues about the nature of work in our evolving economy.

Let me attempt to keep my focus narrowly drawn, although this will necessarily mean some overgeneralization.

Until the past decade, conventional union-side collective bargaining practice resisted the various forms of "multiskilling" or "job amalgamation" of production work. Much too often, our experience as trade unionists was that multiskilling was one of the employer's ways of *not* bringing back those on layoff or on recall lists. Multiskilling has also been regularly employed by management, in a strategic fashion, to whittle away at hard-won, union-negotiated job-evaluation systems, in the name of alleged production modernization.

Ours was a resistance, therefore, built on a perfectly justifiable and rational lack of trust. Over time, labour attitudes to multiskilling have changed, *but only to the degree* that working people and their organizations have adapted their bargaining and job evaluation strategies to new production realities, *and only to the degree* that multiskilling can itself be jointly determined or negotiated.

A week after immigrating to Canada, Mr. Reid began employment with Cominco at Trail, B.C., where he worked for over 11 years. Since then, he has been a full-time employee of United Steelworkers of America in their industrial engineering department, primarily assisting any locals in the capacity of referee or in negotiations. He has also served an apprenticeship as a sheet-metal worker and worked in the shipyards, construction and maintenance environments. His work with the union since 1976 has involved serving on negotiating, pension, trades, apprenticeship and grievance committees and, most recently, job evaluation involving the U.S.W.A. C.W.S. program. Mr. Reid's major focus at present is Ontario's Pay Equity Legislation.

In other words, rational multiskilling strategies can only succeed with the full involvement and participation of those workers whose job descriptions are being rewritten. This should be a self-evident proposition, but it is still vigorously opposed by many Canadian employers.

Multiskilling will win acceptance from production workers, even in very traditionally structured workplaces, if it is pursued co-operatively, with full compensation for the acquired skills and new responsibilities, preferably within the context of a collective agreement and a union-negotiated job-evaluation scheme. Training costs must not be borne by the employee, except insofar as some form of jointly operated training program may already be in effect in the particular workplace.

While all of this may be difficult for some managers to swallow, it is important that we reflect on some background issues that affect multiskilling; for much more is involved in responding to economic and industrial change than letting experts re-engineer the performance of work.

The evolution of employment standards and labour legislation in Canada, in my opinion, will increasingly require jointly determined job-design and -evaluation systems. Pay equity is one important current example. But as other human rights become articulated in employment law, I predict (perhaps a little optimistically) that employers might come to view the involvement of their own employees in the design and evaluation of work as more than a necessary evil.

Multiskilling, in short, must be viewed within the larger context of evolving social pressures and obligations for jointly-determined and "transparent" job-evaluation, whether it is called a pay equity plan, a CWS agreement, or something else. If managers involve their own workers, in good faith, multiskilling need not be a source of serious conflict.

Let me turn to a more specific issue within the multiskilling debate, one that causes me great concern. That is the issue of the skilled trades. Like multiskilling as a whole, this problem is also really several problems. The problem of training is paramount, but it is clouded by conflicting, even contradictory, pressures in the so-called labour market.

We frequently hear, from employers and in the media, that there is a serious shortage of skilled tradespersons for Canadian industry. Trades people immigrating to Canada, particularly from Europe, receive what amounts to almost instant recognition or certification in most provinces.

This creates more tensions than are necessary for the simple reason that there are thousands of Canadian workers who would like a chance at apprenticeship training if it were offered. But such opportunities are very scarce. Managers prefer the quick-fix offshore recruitment answer to the apparently more difficult and long-term investment in domestic training opportunities. Apprenticeships are hard to break into and, in the absence of

any comprehensive national and provincial skills training strategies, employers use the excuse that it doesn't pay to train.

The situation is further complicated by the disarray in the current regime of trades accreditation. We need to move toward a greater and clearer standardization of course outlines, examination standards, and even of the "titles" or trade names. Provincial autonomy in trades accreditation could be balanced by clearer national standards and – dare I say? – perhaps international standards.

But the issue of standardization and the opening-up of skilled-trades training opportunities for Canadian workers confront two major problems. One I have already mentioned is the tragic absence of comprehensive training programs. The word "training" is on the tongue of every politician nowadays, and we frequently hear from our Prime Minister and from our Premier in this province [Ontario] that generous new training schemes are on their way. As time passes, I grow more sceptical.

On the other hand, joint labour-management organizations like the Canadian Labour Market and Productivity Centre, the Canadian Steel Trade and Employment Congress, and the Electronic Industries Council (EEMAC) are all deliberating on or developing joint training strategies that might spur our governments into more comprehensive action.

The second major problem is multiskilling itself. By its very nature, it runs counter to the development of particular trades specializations. No one has come to grips with the question of balance between the "generalists", or multi-skilled workers, and the economy's ongoing needs for trades people. The multiskill approach, if it is not part of a well-thought-out and flexible training strategy, simply dilutes the skill level of the trades. Over time, the generalists or semi-skilled repair people will be found by managers to be inadequate for certain tasks; the managers in turn will have to pay handsomely for the required skilled work by contracting out to companies that employ specialists.

Workers' organizations are understandably concerned about this apparent contradiction at the heart of the multiskilling debate. As Western manufacturing continues to evolve away from mass production and extraction to "small-batch" or flexible production, it is arguable that we will need *more* specialization, not less.

But whatever happens, investment in good-quality training programs for current workers and for our children is one of our most desperate needs.

Application of the Vision

Stephen B. Flewelling

Introduction

As the world becomes more competitive, the pressure on industries such as the mining industry to become more productive and efficient grows intense. Existing management structures and ways of doing things may start to break down under this pressure due to the loss of equilibrium and comfort of the individuals within the organization.

In order to adapt to the change, new ways of doing things are becoming increasingly necessary. One of these "ways" is to change how people function in their jobs. Constant pressure is exerted to "combine jobs", "make people more flexible" and "have management be more resilient and react more quickly", in order to accomplish the objective of increased productivity and, ultimately, profitability and survival. To do these kinds of things it is necessary that the individuals in the organization be "multiskilled".

Traditionally, we think of "multiskilling" as applying only to certain individuals within an organization. For example, it is rational to think of combining the job of a jumbo operator with that of a mechanic so that more efficient use of the jumbo is achieved. If we supply the training necessary, the individual should be able to do this "multiskilled job". Likewise, similar opportunities exist in mine engineering and many other parts of a mining organization. Therefore, if we provide enough training, and apply pressure to produce, the results should just fall out. This is the "microscopic", traditional and obvious part of the use of multiskilled individuals to produce better, more effective, results. But the question must be asked:

> "Is the environment that is created and developed by management a suitable one for the creation and fostering of multiskilled individuals?"

Mr. Flewelling is presently Chief Rock Mechanics Engineer at Falconbridge Limited, Sudbury Operations. Before joining Falconbridge, he held positions of progressive responsibility in operations and engineering at Brunswick Mining and Smelting Corp. in Bathurst, New Brunswick. He is a graduate in Mining Engineering, Queen's University.

This is the macroscopic and broader side of the issue.

Microscopic Issues

On a "microscopic" or practical scale, the industry will definitely require more people to be multiskilled than presently exist. Mining engineers must become more aware of application of the technology in fields such as rock mechanics yet also be able to analyze and make decisions on a professional business basis, requiring business education. Mechanics must become more knowledgeable in the design and maintenance of electrical systems and electronics in order to maintain more complex equipment. Generally speaking, every person in the organization will have to become more technically and intellectually multiskilled than they are at present.

In the future we will be required to innovate on a higher degree whilst drawing on a greater depth of high technology. To do this, we must manage the process of innovation and manage the technology and technological change. Our people must have multiple skills in addition to their current ones. For example, engineers and managers will require additional skills in high technology, general management, project management, communications and human behaviour.

To do this, a significant commitment of money and time must be made to continuing education and training in order to prepare our people for future requirements. I feel the record of the mining industry in this area requires improvement. Other industries are far ahead of the mining industry. For example, General Electric in the United States spends $500 million per year on the training and education of its people. I doubt the Canadian mining industry spends this in total.

We must upgrade our on-the-job training and development programs if we are to adapt to a changing environment. This needs to be a combined effort between mining companies, universities and community colleges. The education must be continuous, not batch-orientated. Time for training and development must be built into the jobs of all of our people.

Macroscopic Issues

A larger challenge, however, is that we must change the culture of the industry. We must create a "multiskilled culture" which fosters increased organizational effectiveness through more effective, skilled personnel.

A "multiskilled culture" is one where people are encouraged to understand what their coworkers are doing, where their input is desired and accepted,

where management trusts the instincts and abilities of the people within the organization. We must break down barriers and hurdles created by management for "organizational efficiency".

To achieve a "multiskilled culture", the traditional barriers between functional departments, between management and unions, between engineering and production and many more, must come down if we are to succeed.

Significant barriers will exist where management does not have a well-developed strategy written down into realistic incremental steps allowing us to go from where we are to where we want to be. How clearly have we defined where we want to be? How much time and money have we spent on developing such a strategy? How many strategic thinkers are employed and developed by the mining industry? How many attempts have we made to change the way people think? Not too many!

In order to develop multiskilled individuals, the appropriate culture must exist or be created. This can be developed in one key way: by having management present cohesive, well-thought-out strategy, with participation from the entire workforce, through a multiskilled, professional management team with substantial ability to think strategically and supply the required vision.

Mining Employment in Canada

John A. MacDougall

The mining industry is extremely important to the wellbeing of Canada. In 1989, the industry produced metals, nonmetals, structural materials and coal worth $21.5 billion.

Canada's mining industry is also extremely important to the world. We are the world's primary exporter of minerals and metals and the world's third-largest producer.

Since an industry is only as good as the people in it, I was delighted to learn that the Centre for Resource Studies here at Queen's University decided to organize a conference on human resource planning for the mining industry.

This is a subject that is very close to my heart. A few years ago, in my riding of Timiskaming, a traditional Ontario mining area, more people were employed in the mining industry than in any other industry. In the past year and a half, about 600 mining jobs have been lost. And at the end of this week, another 600 will disappear with the closing of the Sherman and Adams iron ore mines.

That adds up to 1200 jobs. This is not some economists' adjusted number, seasonally or otherwise. Those are 1200 real jobs, 1200 real people out of work.

Neither I nor people in my riding are criticizing the companies involved. We all know that the mining industry is a cyclical one. Orebodies will run down, the economics of particular mines will change over time. The companies in my area acted extremely responsibly and are to be commended for their actions to help the communities.

Nevertheless, most of the people being laid off have not found other jobs.

Mr. MacDougall has been the Member of Parliament for Timiskaming since 1982 and is currently serving as the Parliamentary Secretary to the Hon. Jake Epp, Minister of Energy, Mines and Resources. His numerous committee duties have included acting as Ontario Member on the Legislative Committee studying the Canada-U.S. Free Trade Agreement and Vice-Chair for the Standing Committees on Aboriginal Rights and Northern Development, and Environment and Forestry. He is also an active member of the Tory Caucus Mines Committee. A successful career as a mining equipment salesman has provided him with the background to make valuable contributions in these activities.

The situation in my area is not unique. In Canada as a whole, employment in mining, milling, smelting and refining peaked at just over 196,000 in 1980. Then the country hit rough economic times, and the mining industry, like many others, underwent considerable turmoil. Today, employment in mining, milling, smelting and refining now stands at approximately 151,000. Yet the industry is now 120 percent more productive than in 1982.

The Challenge

While the industry's productivity has improved, there is no reason to be lulled into complacency. Many of the mines are old, with orebodies of declining quality. Competition will only increase in the years ahead. In particular, the developing world, with its high-grade ore bodies, low labour costs, and dire need for development, will give us a good run for our money. Our best means of competition will be a highly productive workforce.

The challenge I want to pose to you today is: How can we best prepare to cope with change so that the Canadian mining industry maintains its pre-eminent place in the world economy, and so that Canadians as individuals gain the maximum benefit from their resource wealth? On the individual level, how can those in the industry gain the greatest possible contribution while achieving job satisfaction?

For human resource planning, I see the problems breaking down into two areas. The first is the training and retraining of those already in the industry. The second concerns attracting people in the industry.

Training Those Already in the Industry

Let's start with those already in the industry. Mining is fast becoming a very high-tech industry. New mines are full of remote-controlled, computer-assisted, electronically driven equipment. As technology advances, how do people in the business hone their skills and stay up to date? How does business make sure it gets, and keeps, the most competent people?

Large companies do a good deal of in-house training. But what about the many small companies? Not long ago, small gold mines had difficulty starting up because of problems in recruiting skilled people.

A related problems concerns those skilled mining tradespeople who wish to move into management. How far can they go?

Part of the human resource problem often revolves around the fact that the mine site is in a remote location. This can be both a help and a hindrance to keeping good employees.

On the positive side, as I can attest, many people from remote communities enjoy the lifestyle and wish to stay in these communities. But the skilled miner may well find that his skills are very similar to those in demand in urban areas. The attractions of the big city are too good to pass up.

Remote mines have had to be especially innovative to compete with the attractions that larger centres offer to skilled tradespeople. For example, I understand that the Nanisivik Mine provides day-care facilities for all families working in the community. Another remote mine, Polaris on Little Cornwallis Island, actively recruited couples to work at the site.

So far, I've discussed the question of training for the mining and minerals industry in terms of efficiency for the industry, getting the best people into the most appropriate jobs and keeping them. But the question of training and retraining has another, somewhat poignant, aspect for the mining industry.

Every mine that opens is going to shut down ... sometime. Training people means helping them acquire the right skills, and helping them to be sufficiently flexible so they can either move to other companies when a mine closes, or to other industries in their own community – provided the community has other industries.

Attracting People to the Industry

The second problem – attracting good people into the industry – seems to be to have several aspects.

One involves the cyclical nature of the industry. When the cycle is at a low point, when demand is down, students with an eye to future fortunes ignore it. The cycle of course turns in a few years, demand is higher, and there just aren't the skilled people available.

The Canadian Institute of Mining, Metallurgy and Petroleum publishes an annual compilation of enrolment and expected graduation in the earth sciences in Canadian universities. Lamentably, the trend for several years has been down. From 1984 to 1988 the number of graduates has plummeted from 1153 to 768.

The problem of attracting good people into the industry may also be related to the industry's image. Kids today may be better educated than ever before. And they surely want a good future. It may well be that if students think of the mining industry at all, they think of it – wrongly – as dirty, dangerous and environmentally dubious. You know, and I know, that simply isn't true. But the industry does have its work cut out for itself in trying to correct the image.

Another aspect of the industry's image is important to mention. That is, women in mining. The numbers are increasing, but slowly. Leaving aside any considerations of equity, and sticking to hard, ruthless economics, no business

can ignore the potential of half the population and stay competitive internationally. It is in the industry's own economic self-interest to recruit and promote women. This may also bring greater stability to the workforce in remote communities.

The pendulum of skill requirement is shifting from brawn to brain. Whether it is a matter of planning, operating or maintaining computer-assisted, electronically driven, remote-controlled equipment or whether it is a matter of working as geologist, accountant, human resource planners or the myriad other jobs in today's modern mine, women can do just as good a job as men.

Initiatives

So, what do we do about the problems I have raised? The federal government, the provincial governments, educational institutions, companies, and unions have undertaken various activities.

At the beginning of this speech, I referred to the closing of Dofasco mines in my riding. Because of the advance notice Dofasco gave, a community adjustment committee was established, which was able to take advantage of the federal government's Canadian Jobs Strategy funding. Employment and Immigration Canada, the Canadian Steel Employment Trade Council, the company, the union, and local groups worked together. As a result, the Northern College of Applied Arts and Technology at Kirkland Lake has provided a range of training to help the workers affected to diversify their skills and so improve their marketability.

I have also been very interested to hear of the pioneering work done by Cambrian College and Inco in Sudbury. The College and the company have cooperated in devising a program to offer technical and mining skills to high school graduates who are interested in a career in the industry. The province is to provide financial help.

Efforts to attract people into the industry are also being made all over the country. For instance, I understand that the Ontario Mining Association has arranged a number of mine tours for high school guidance teachers. This sounds to me like an excellent way to start turning around the image, and provoking interest.

Other organizations have also made efforts to interest students in the industry. For instance, one of the projects under the Canada-Nova Scotia Mineral Development Agreement involves sending dynamic mining people into schools to give students a fair and attractive view of the industry.

I was also delighted to hear that Inco recently pledged a $1 million donation to Queen's University to update aging mining equipment in university laboratories. All these activities are laudable.

But I think that we need to increase dialogue, to increase cooperation among governments, companies, union and academic institutions.

To this end, I have recently written my provincial counterparts, and a number of industry and union people to invite their ideas on how we can devise a coordinated approach to safety, health and work adjustment in the mining industry. I believe that a concerted effort among us all will give us the best hope of adapting to the changes we face.

The Northern Telecom Approach to Recruiting

Tom Hennebury

I'm quite proud of Bell Northern Research's (BNR) efforts in recruiting, attracting and developing top-notch people. I believe they represent a dynamic, well-planned response to what all of us here recognize to be an urgent contemporary challenge.

That challenge is to increase Canada's supply of highly qualified scientists and engineers in the face of inevitable shortages over the short term and perhaps over the long term as well.

I offer my remarks to you today, not for the opportunity to plug BNR, but in the spirit of advocating action.

First, I plan to give an overview of these initiatives. Then I'd like to use that overview as a kind of springboard to a discussion on what can be done to move society beyond the level of talk and into the area of workable action between business and education.

Figures 1 and 2 give a picture of BNR to put my remarks in that perspective. BNR develops leading-edge telecommunications products and services. Areas of expertise include network products, integrated office products, fibre systems, and hardware and software technology development – especially software.

BNR Competes in a Big Market

In 1987 telecommunications information networks generated US $118 billion in revenues within North America alone. The market in telecommunications equipment and services in 1987 was worth US $75 billion. By the year 2000, it will be worth $300 billion, a growth unmatched by any other industry.

Vice-President, Human Resources, for Northern Telecom Canada Limited, Mr. Hennebury joined the firm upon graduation from McGill University in 1965. He has held various senior management positions within Northern Telecom Canada and Northern Telecom Limited. Most recently, he was Vice President, Human Resources and Administration, of Bell-Northern Research.

Figure 1. BNR locations

- Canada's largest individual research and development lab
- 4100 at Ottawa headquarters
- nearly 1800 additional personnel at five other locations in the U.S., Canada, and the U.K.

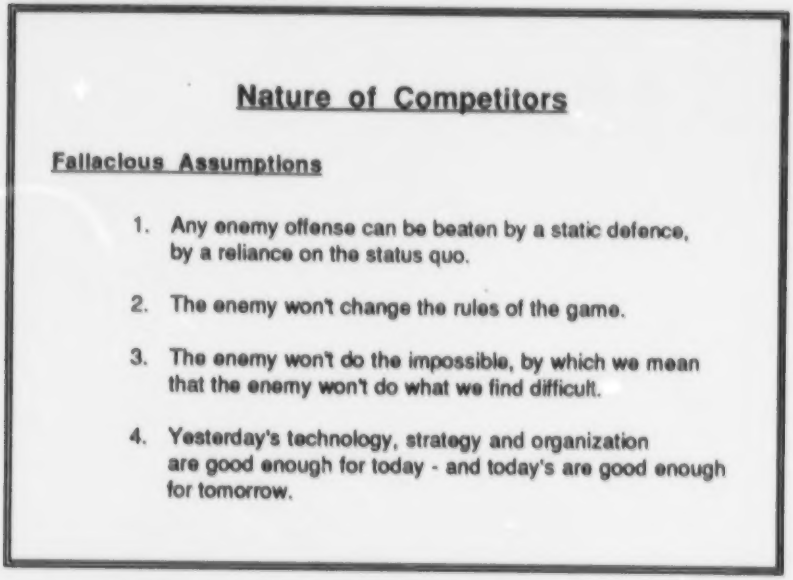
Figure 2. Information systems

Information Systems

- Access codes for 455M phone lines around the world via your telephone book
- Telephone network carries voice, data and images around world
- North America 138M lines or 51/100 population
  $118B (U.S.) revenues in 1987
- Canada: 13M lines or 51/100 population
  $8.4B (U.S.) revenues in 1987

World's Largest Distributed Computing System

Figure 3. Nature of competitors

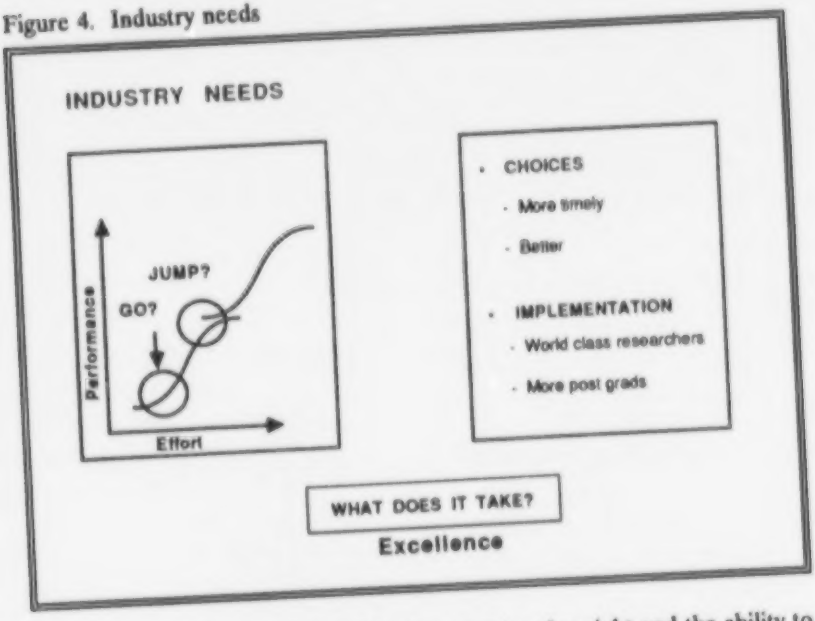

Nature of Competitors
Fallacious Assumptions
1. Any enemy offense can be beaten by a static defence, by a reliance on the status quo.
2. The enemy won't change the rules of the game.
3. The enemy won't do the impossible, by which we mean that the enemy won't do what we find difficult.
4. Yesterday's technology, strategy and organization are good enough for today - and today's are good enough for tomorrow.

The recent events in eastern Europe will push this figure up even higher. By the year 2000, eastern bloc countries, including the Soviet Union, will have to spend over $130 billion to modernize their aging telephone networks. They will need western technology to do so. With stakes this high, competition will be fierce. BNR and Northern Telecom face some of the toughest and biggest competitors in the world: Siemens (West Germany), AT&T (U.S.), NEC (Japan), Ericsson (Sweden), and Alcaltel (France). By the year 2000, we believe only three or four telecommunications firms will survive to offer full product lines. The rest will be reduced to niche players. Northern Telecom and BNR intend to be among the survivors. Therefore, we can never fall victim to any of the bogus assumptions you see listed in Figure 3.

Neither can other Canadian business – especially with free trade now a reality and a 1992 Europe just around the corner. Meeting and beating the competition means getting the best products to market ahead of the competition. That means knowing when to go and when to let go. Companies like BNR must constantly monitor the life-cycles of the products – *cycles which often last for only two years or less*. We must know when a particular technology is reaching maturity and probable obsolescence. Then we have to be ready to jump over to a new technology we've identified as its potential replacement.

Once we spot the gap – or discontinuity – between an existing and an emerging technology, we have to choose exactly the right moment to make our move. (See Figure 4.)

Figure 4. Industry needs



Making the right choice at the right time requires foresight and the ability to take risks. Making the right choice also calls for two other critical factors: people who can identify and develop new products and applications over steadily shrinking intervals of time; and people who can act quickly in doing these things. The key word here is *act*.

Again, it's a matter of excellence. In today's world of rapid technological change and discontinuity, excellence means a strong commitment to R&D, the willingness to act, and exceptionally qualified people to carry out these functions. BNR has made a firm commitment to these values.

Northern Telecom's annual R&D budget exceeds $700 million. Competitors like Seimens, NEC, and AT&T all have R&D budgets of over $2 billion per year. Spending, therefore, must be precisely targeted at commercially viable applications. We can't afford to have our R&D efforts take the occasional stroll up blind technological alleys. We have to be on the right commercial path all the time.

The other area where BNR continually renews its dedication to excellence is through its workforce. Our employees must be of exceptionally high intellectual and technical calibre. And we must have them in sufficient quantities to produce the advanced technological designs and applications which keep us in business. As Figure 5 shows, two thirds of all our employees hold university degrees. Nearly 40 percent of degree holders have postgraduate degrees, and 70 percent of all our degree holders are in the fields of electrical engineering, communications, or computer science – the disciplines most critical to our continued success as a global competitor.

Figure 5. BNR education composite

Major	Bachelor	Master	PhD
Engineering-Electrical Systems, Communications	1103	538	106
Computer Science	808	308	25
Mathematics, Statistics	127	50	17
Physics, Physical Chemistry, Applied Science	137	46	37
Chemistry, Chemical Engineering	21	21	13
Mechanical Engineering	67	10	1
Metallurgy, Metal Engineering	3	2	1
Engineering-Civil, Industrial, Structural	40	24	5
Business Administration, Law, Public Relations, Engineering Administration	61	63	8
Economics, Finance, Accounting	36	19	0
Psychology, Human Factors	18	17	23
General Arts, Library Arts	76	62	17
Totals by degree	2497	1160	253
Employees = 5854		Total with degrees = 3910	

BNR's mission is to ensure we have an ongoing supply of qualified researchers. The driving forces behind this mission are: the obligation to do unremitting research and development, and the absolute necessity to replenish and enlarge our supply of outstanding technical talent. Future systems require designers with more technical depth. But as in any successful mission, success comes only to those who act. BNR – and other Canadian firms – cannot afford to remain passive in the vital area of human resource development and recruitment.

Worldwide shortages in engineers alone are reaching critical proportions. Ford motor company, for example, is predicting a U.S. shortage of 400,000 by the end of the 1990s. Competitive victory under these constraining conditions

demands action and proaction. Action translates into forging effective partnerships with those institutions most immediately capable of providing these people to us – Canada's universities. We have made a practice of building university pipelines to supply the right quantity of top-quality strategic skills and knowledge.

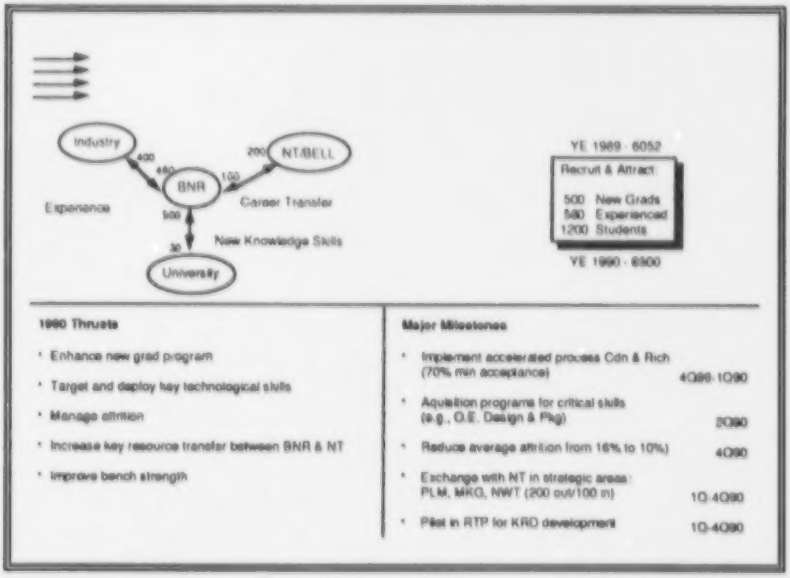
But we can neither begin nor end with universities alone. In 1990s, we must reach into all levels of education – from our secondary schools right down to kindergarten classes.

BNR relies on three sources for its manpower supply:

- our customers and industrial competitors (we recruit close to 600 experienced people from this sector every year);
- Northern Telecom. We transfer people to Northern, they transfer people to us;
- universities.

As Figure 6 indicates, our goal is to attract and recruit at least 500 new university grads in 1990. Reaching that goal – and similar goals – is getting progressively more difficult.

Figure 6. Resourcing



There are two major reasons for the increasing difficulty in attracting and recruiting new grads: the marked absence of a technological culture in this country, and a downward demographic trend. First, the lack of a technical culture: for example, Japan has four times as many engineers as Canada, while Canada has 20 times the number of lawyers. In 1988, the percentage of students who earned degrees in engineering disciplines represents only 6.8 percent of all undergraduate degrees in this country. That's only a 1.3 percent increase since 1974. The Canadian Council of Engineers has estimated that total demand for all engineers will increase by an annual rate of 3 percent between now and 1995, or roughly 20 percent of the total, while the supply of engineers over this entire period is expected to grow by only 12 percent. In electrical engineering – a key discipline for BNR – fewer than 1800 bachelor degrees will be granted this year, compared to 2200 in 1987. Computer science enrolment last year was only 8000 – a 36 percent drop from an enrolment of 12,500 just four years ago.

The number of young Canadians entering the workforce is also declining. In the 1970s in Ontario alone, the workforce grew by 3.6 percent a year. Since 1986, that growth-rate has fallen to only 1.3 percent. It will remain at this level until at least 1996. As a result, the supply of potential new employees is expected to drop by a full 25 percent over the next decade.

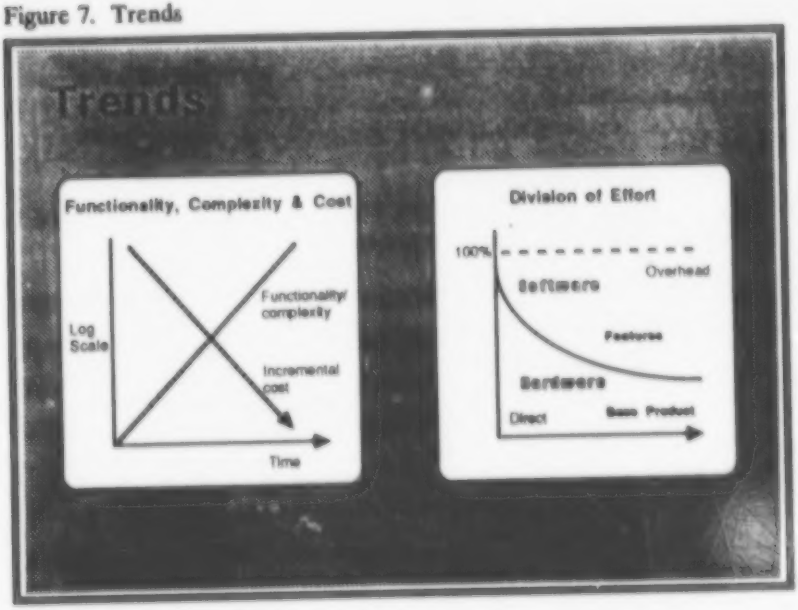
University Interaction Program

The focus of our University Interaction Program (UIP) is shaped in part by specific technological trends, as shown in Figure 7. These trends have largely been responsible for the increased demand we now are seeing for certain kinds of technical professionals – primarily, electrical engineers and computer scientists. Developing these and other potential employees while they are still students is an important component of UIP's mandate. Another important component is targeting and encouraging academic research that is relevant to BNR. These and other objectives are met through UIP's various initiatives and through its emphasis on research consortia.

The trend of technology today is toward ever-more functional products at ever-more affordable cost. Approximately every five years – as the diagram on the left in Figure 7 demonstrates – technology increases its functionality and complexity by a factor as high as ten. As the performance of technology grows, its costs per unit function drop at a corresponding exponential rate over the same period. This principle is behind the tremendous progress we have seen in the field of data-processing hardware; for example, microprocessors today are as powerful as mainframes were just nine years ago, and they sell for a fraction of the cost. What all this means is that successful hardware

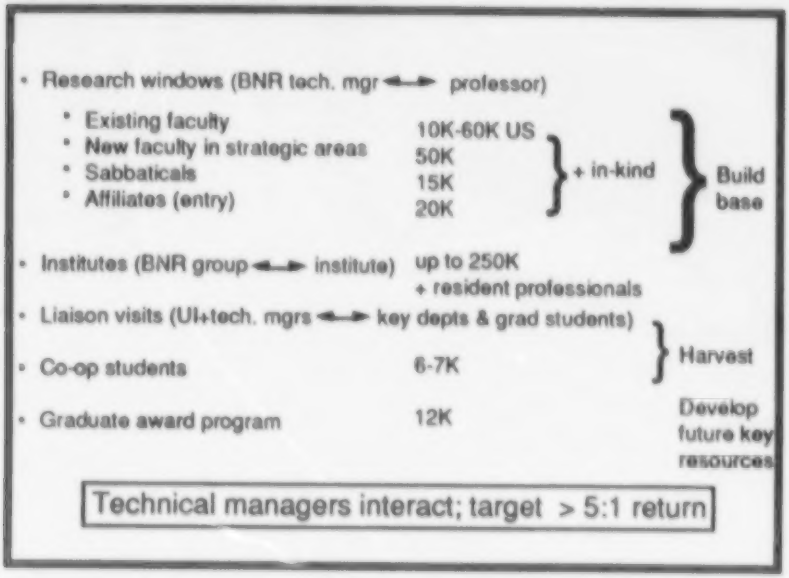
technologies often reach a certain level of affordability which render radical structural change impractical, lengthy and time-consuming. Consequently, software development – the ability to enhance a hardware technology's applications capability – becomes crucial, and that's what the diagram on the right illustrates. What these two trends signify is that companies like BNR must constantly enhance the applications potential of their hardware products with software innovations. In fact, over 80 percent of our R&D investment is devoted expressly to developing new adaptations and expansion of existing products and designs.

Figure 7. Trends



To sustain the pace of this innovation, we need a constant influx of computer science specialists, electrical engineers, and technical managers – people who can keep coming up with new applications for base hardware products. UIP initiatives link BNR dynamically to the world where these people are now being educated and doing research. These are shown in Figure 8.

Figure 8. Interaction program thrusts



Research window grants provide an opportunity to forge long-term relationships with university faculty engaged in research in areas relevant to our business and market concerns. Under this initiative, BNR often provides an unrestricted grant to already-funded research projects undertaken by faculty. A faculty member teams up with a BNR technical manager who furnishes advice and guidance, while monitoring the results and progress of the individual's research.

BNR maintains a close involvement with various research institutes, which which bring together scientists and engineers from business, government and the private sector for the purpose of doing cooperative, market-oriented research in leading-edge technologies. Research consortia are proving to be one of the most effective mechanisms for innovation in Canada today – if only because they aren't beset by the annoying bureaucratic structures that so often hamper flexible, creative research in larger, more tradition-bound institutions.

For student recruiting, liaison teams maintain constant contact with key Canadian and American universities noted for having strong departments in electrical engineering and computer science. Our liaison initiative allows us to identify the best and brightest students in these and other technical fields and to develop contacts with their professors. Over time, and with patience, we hope to attract many of these students to BNR.

Encouraging recruitment is also a major objective of our co-op program, which allows university students to work at BNR during breaks in the academic year.

Last year we funded 14 faculty positions in Canada (many with the cooperation of NSERC), one of which has been terminated. Others are being planned. By 1995, we expect this effort to be providing more than 25 new post-grads per year. Last year, as well, we hosted 10 visiting professors on sabbatical.

Working with Universities

Since 1982, our postgraduate student awards program has supported the studies of 113 employees. Right now, 70 award winners are pursuing advanced studies at universities throughout the world. In 1988 our Canadian liaison teams visited over 20 universities. They also developed or maintained contact with 250 faculty members and more than 500 postgraduate students.

BNR is also the largest private-sector employer of co-op students in Canada. Last year over 800 spent at least one semester working in our laboratories. Figure 9 sets out these initiatives.

Finally, BNR's active participation in research consortia has accelerated greatly (see Figure 10). Currently, we are involved in 12 such cooperative research institutes located in both the U.S. and Canada. In the last three years alone, we have helped create or have joined up with nine.

That, in a nutshell, is BNR's University Interaction Program. It has served BNR well. Despite shortages in the disciplines we require, we have managed to double the size of our workforce, from about 3000 in 1982 to over 6000 today. Despite, too, the fact that Ontario's workforce is growing older in its average age, the average age of our workers is actually getting younger.

Partnerships with Schools

Our partnership, however, does not end with universities. Partnerships with primary and secondary schools are also important. Primary levels are vital because it is at this level where learning is at its most unselfconscious and where exposure to technology is often least affected by preconceptions and misconceptions. Secondary levels are critical because these are places where career decisions are normally first formulated and electives in science and math chosen or discarded on the basis of those decisions.

Figure 9. Working with universities

Figure 10. Research Consortia

	STARTED	MEMBERSHIP	RESEARCHERS	FOCUS
PARS TELECOM	1971	U de Q / BNR	BNR PREMISES	TELECOM NETWORKS
CCSP	1982	NC State / 13 IND	CAMPUS	COMM SIGNAL PROCESSING
MCNC	1983	9 U / 30 IND	BUILDING	COMM SIGNAL PROCESSING
WASHINGTON	1986	1 U / 6 IND	ON CAMPUS	SUB MICRON SILICON
ATRC	1986	2+ U / 4+ IND	BUILDING	FAST PACKET SWITCHING
TRIO	1987	4 U / 13+ IND	NETWORK	TELECOM SYSTEMS
ITRC	1987	4 U / 21+ IND	NETWORK	TELECOM SYSTEMS
OCMR	1987	9 U / 21+ IND	NETWORK	INFO TECHNOLOGIES
LASER & LIGHTWAVE	1987	1 U / 35 IND	CAMPUS	MATERIALS
PRECARN	1987	0 U / 35 IND	NETWORK	ADV TECHNOLOGIES
SSOC	1989	0 UNRC/+4 IND /ATRC/	BUILDING	AI, ROBOTICS
ITR	1990?	13 UNATRC/13 + IND /CRC/	NETWORK	OPTOELECTRONICS
				BROADBAND/WIRELESS

There already are several worthy projects under way that involve private firms partnering with our schools. Northern Telecom has developed its National Institute, where every year 75 teachers from all levels are honoured for their leadership efforts in science and technology education. There's also a BNR initiative that's part of our new partners-in-education program. It involves a local school in the Ottawa-Carleton region, Earl of March Secondary School (see Figure 11). BNR works with the students and teachers there to introduce them to realities and challenges of the telecommunications business.

Figure 11. Earl of March Secondary School

MISSION STATEMENT

- Encourage professional development for teachers and BNR staff
- Encourage post-secondary education - especially science and engineering, especially females
- Give students opportunity to interact with the workplace

WHAT LEARNED

- Interventions: selectively and strategically from grade 7 - 13
- Teachers: strategic messengers
- mutual understanding takes time

UNDERSTAND AND GROW TOGETHER

Conclusion

My theme today has been action, and my subject matter has been a kind of call to action - a demonstration of what private sector organizations can achieve when they actually decide to do something about a problem. Canadian business and industry needs to take action, collectively and individually, if they want an education system that can respond and adjust to the technological, competitive, and economic realities of this era.

Does business truly want such a system? Given its past track-record, I sometimes wonder. We hear about the urgent need for more R&D in this country. Yet our R&D remains stuck at only 1.3 percent of GDP, giving Canada the dubious honour of being the only major OECD country where private sector R&D is lower than that spent by the government. We've all read studies which demonstrate the absolute necessity of strengthening engineering education in this country. Yet 70 percent of the manufacturing firms in Ontario do not have even one engineer on staff. It is common knowledge among business and industry that we are in the midst of a massive shortage in the skilled trades. Over 160 occupations in Ontario alone are affected; yet again, in spite of this knowledge, 75 percent of Canadian firms do not offer their employees formal training programs.

The Canadian Manufacturers' Association, the Ontario Premier's Council, and the Conference Board itself in a recently tabled position paper have all argued that a vital and undeniable link exists between education and national competitiveness.

Still, Canadian business and industry lag woefully behind firms in other countries in their support for education, even at the university level. In 1987 only 3 percent of firms here were supporting research ventures at post-secondary institutions. The time for study – at least on the subjects just mentioned – is over. We know the facts. We've established the case. It is now time to act and to convince private sector firms to act toward establishing dynamic initiatives among all levels of the educational community. One way we can do this is to publicize the education initiatives launched by other companies, large and small, on local and regional, as well as at national, levels.

The Conference Board's suggestion to establish a standing education conference, held annually, would greatly advance this process. It would bring business people together with educators and government officials every year to deal with educational issues that concern them. But the conference should not be merely a forum for discussion. It should also be a platform for sharing concrete experiences – actions, in other words. Many of the initiatives I've talked about today are not monumental endeavours. Far from it. They are small gestures, modest steps on the road to fashioning a society where science and technology is valued, understood, and accepted as an integral, necessary part of an individual's experience. When this society comes into being – as it must, and as it better – the benefits will be significant:

- industry will have the human resources it needs to compete;
- a technologically literate citizenry will recognize and support the importance of R&D, technical training and education, and technological excellence;

- our schools and universities will be more responsive to the realities and imperatives of competitive endeavour.

This is not Utopia. It's an attainable possibility. But we must act to get there.

The Ontario Government Relocation Program

Arnold Bock

The Ontario Government is decentralizing head offices in a variety of ministries. The Relocation Program is three years old now and is nearing completion in Northern Ontario. The mining industry tends to be focused on the more remote areas of the country and, in the sense of attracting people to the industry, attracting people to the geography, location and so on, that's the nature of this Program. It deals with people who have chosen to enter a particular line of work, whether it's managerial, technical or professional, and in a particular location, like Toronto.

When one attempts to attract people to a new destination, one which the political process has arbitrarily chosen, it sets in motion a whole series of challenges, not the least of which is the people side of it. (Quite frankly, that is only one of the challenges, because we are creating new facilities with the purpose of integrating ourselves into the new communities.) The important point that I want to emphasize is that people work and live *where* they work and live because of a conscious choice on their part at some point in time. Now, they may have evolved into it, but they've established a whole social structure and professional network that reinforces it. When they are told out of the blue someday that "your job is going to go someplace 400 miles away and you're welcome to come with us", it's a shock to say the least.

Mr. Bock is currently Executive Director, Program Development and Management, for the Realty Group of the Ontario Ministry of Government Services. During the past three years, he has been responsible for corporate coordination of the Ontario Government's program of head-office decentralization to several northern Ontario communities. Included were the full range of human resource issues, operating program transfers, design and construction, as well as community relations activities. Mr. Bock is a graduate of Wilfrid Laurier University and the University of Western Ontario. He began his career as a secondary school teacher, but has been employed by the Government of Ontario for the past twenty years. During this time, he has held a wide range of managerial positions with the Ministries of Municipal Affairs, Revenue and Government Services.

This Program was evolved about 10 years ago on a smaller scale but with a roughly similar nature. Having been involved with it for some time, I have concluded quite simply that people are where they are because they want to be there, and it doesn't matter where you are – that tends to be where you prefer to be. At one stage in my worklife, I went from Toronto to North Bay. I recall that I would encounter in the elevators colleagues who had heard that I was leaving and said, "You're going to North Bay? Why would anybody want to leave Toronto and go to North Bay?" Equally, when I told people in North Bay that I was returning to Toronto three years later, the response was, incredulously, "Why would anybody in his right mind want to go from God's country down to that hell-hole with people racing around with no apparent rhyme or reason?" Well, the essence of what I'm saying is that it hinges on people. We've moved operations from Toronto to Kingston in the past, nearly as short a distance as consolidating them in Oshawa. It's merely a stone's throw down the road but it's a psychological hurdle nonetheless. And it may as well have been 400 miles for all intents and purposes. Most people don't wish to take the employer up on this option.

Relating this to your industry, I'm sure that relocations are the essence here. What I do think, though, is that I can take a few of the responses that we get from our people and perhaps relate them and develop them a little further. I should point out that we are transferring head office operations from Toronto to North Bay, Sudbury, Sault Ste. Marie, Thunder Bay and a small group for Timmins. Having the five major centres should in itself be an attraction. For people used to an urban environment, the shock isn't quite as great. Nonetheless, there is a substantial difference in distances and in the types of communities. There is a certain logic in the transfers; for instance, the Ministry of Northern Development and Mines which you and your businesses probably deal with at one time or another is being consolidated in Sudbury. As well as a new head office building for the Ministry, a new laboratory for the Ontario Geological Survey is being built on the campus of Laurentian University; also attached to that, the Mining Health and Safety group of the Ministry of Labour is being moved from Toronto and consolidated in Sudbury.

In terms of some of the other locations, I suppose that the public does not perceive any logical reason for the transfers, but one of the things that I consider important, but which many people forget, is that with technology – particularly your kind of technology – the ability to operate from remote locations is now possible not only technologically but cost-effectively as well, in a manner which never existed in the past. Being able to function, whether it's from your home or whether it's from Thunder Bay and connected to Toronto and Ottawa and so on, is a matter of fibre optics and digital signals, etc. It's just a matter of course.

Indeed, increasingly for anybody who is trying to operate in Toronto, the ability to recruit, to retrain, and to retain staff is becoming difficult to say the least. The competition is severe; there are lifestyle considerations, such as spending an hour and a half going each way to and from work and the question of young families' ability to afford a home. That kind of thing is increasingly becoming a factor. We're finding that, as a result of decentralization, replacing staff for vacant positions is easier. People are joining us *because of* the new location, not in spite of the relocation, and that's a very important fact. The challenge for the organization, or course, is that it loses the existing people and has to integrate the new ones and develop their knowledge. But once having done that, the quality of people available, especially at the more junior levels – the entry levels and the clerical levels – is superior in the extreme outside of the greater Toronto area. Most of the professional, technical people, (the geologists and so on) were virtually to a person quite resistant to the whole prospect of going to Sudbury. Their argument was they spent most of their time dealing with the head offices of your companies down on Bay Street rather than in Sudbury or wherever. I don't know how true that is, but I think it acts as a cover for the fact that, for lifestyle reasons for the family and especially children, and spouses' employment, they wanted to stay where they were.

The tendency is to see something this disruptive as only a set of problems to be dealt with somehow. Nevertheless, in creating an organization, this is an opportunity and I cast it in that light. An organization needs a constant flow of new people in, which means that some people have to leave as well. The government is no different. Indeed, while Ontario hasn't been as badly victimized by constraint, the reality is that we have not been hiring in the same manner as during the 1960s and 1970s. Constrained dollars means constrained staffing, which means that people are less inclined to take a flyer and go elsewhere, and it means that our attrition level is quite low. I construe the transfer as an opportunity for the organization to renew itself, to rejuvenate itself both in terms of the age structure and profile of type of staff, and the outlooks and the philosophy of their approach to business.

It also gives an opportunity to redress imbalances beyond the age issue. As all of you are aware, employment equity is increasingly a priority of employers. As an employer, the Province of Ontario has five target groups, Francophones, natives, women, visible minorities and the physically challenged (as the term is). While there are no targets or legislated programs, we are able to take stock of the composition of the population in our respective communities and to staff and recruit in a manner which is reflective of those communities. So again there is an opportunity there.

Most of the people do not relocate with us, but the reason varies based on a lot of factors. I can almost develop a profile of the type of person who will

move and the type of person who won't, and it goes along these lines. The people most likely to move their job and relocate their residence are those whose income is higher rather than more modest, who have a lot of time invested in their career, who probably therefore have fewer opportunities or options available to them, who have a spouse who does not have a career, who have children who are either quite young or independent.

I noted their income levels are quite high, which is reflected in the fact that they were not at the entry level, they were not clerical and so on. Therefore our biggest problem is what to do with people who don't wish to relocate. We do not take the position that as an employer we really don't have an obligation or that our obligation stopped with those letters spelled out in the collective agreement – nothing more – and if somebody isn't unionized, that is too bad. We probably are in a position to do something about it because we continue to remain as a major employer in the Toronto area.

There is attrition, which means there are openings. With some planned and aggressive measures, we can in fact integrate most of the people into the remaining organization as long as they are given some additional tools, which range from training to some sort of precedence in competitions for vacant positions. Of course, it must be phased out over a longer period. Because a large percentage of our people are unionized, we established a protocol, so to speak – a set of governing principles – at the outset, and designed a consultative mechanism. We meet on a regular basis from six weeks to two months apart and essentially address and deal with the issues that are common in both groups. Representatives of the bargaining unit as well as the managers attend.

The consensus would be that, in the case of our current program, we have not created jobs as a make-work exercise at all. We have placed virtually anyone who was affected and didn't wish to relocate. Issues that had the potential to create antagonism in the relationship between union and management have not emerged as major issues, primarily because of a joint determination to consult and to resolve and to come to a solution that is in the best interests of everyone concerned.

Implications of Geology Enrolment for the Mining Industry in Canada

John M. Dixon

Geology enrolment has a history of fluctuation coupled to the fluctuation in the mineral and petroleum exploration industries. Enrolment in geology programs in Canada currently reflects a decade of unusually severe instability that has caused problems for the earth science departments of Canadian universities and that has grave implications for the supply of personnel to the mining industry in the coming years. This note puts the current enrolment picture in the context of the past decade and reviews the implications for the immediate future. Finally, it suggests some steps that could be taken by the mining industry to help alleviate the foreseeable difficulties.

In this discussion, the term "geologists" is used inclusively, encompassing geologists, geophysicists and geological engineers (that is, those specialists who graduate from university departments of geology, geological sciences, geological engineering, earth sciences and geophysics). However, other earth scientists such as physical geographers and mining engineers are excluded.

Geologists constitute a important component of the human resources of the Canadian mining industry, both in the upstream part of the business, exploration, because the industry has no future unless it maintains a stable level of ore reserves, and in the downstream or production side, where they are involved in mine planning and extraction. At the undergraduate level, university enrolment is currently at such a low level that personnel supply to industry is in jeopardy. While post-graduate enrolment is above its long-term

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Dr. Dixon obtained a B.Sc. in Geological Sciences at McGill University (1970), and his M.S. (1972) and Ph.D. (1974) degrees in structural geology at the University of Connecticut. He joined the Department of Geological Sciences at Queen's University in 1974, and has been Head of the Department since 1986. His research and teaching are in the fields of structural geology and tectonics.

Dr. Dixon has served as chairman of the Council of University Departments of Geology (Ontario), and is currently a member of the Board of Directors of the Centre for Resource Studies. He has a strong interest in the development of academic programs that will produce geologists who can adapt to the changing needs of industry and society.

average, the low undergraduate enrolment of the next few years will not turn out sufficient graduates to allow this level to be maintained.

There is a growing demand for geologists who will have responsibilities in environmental protection and reclamation, but this sector of the industry (and of the university programs) is in a state of flux and trends are difficult to quantify.

Enrolment figures for Canadian earth-science departments are collected annually by the Council of Chairpersons of Canadian Earth Science Departments (CCCESD) under contract to the federal Department of Energy, Mines and Resources (EMR). (The complete set of data from the 1990-91 survey can be obtained directly from EMR or from the Chair or Head of any Canadian geology department.)

Figure 1 illustrates the long-term pattern of enrolment at Bachelor's level, Master's level and PhD level for the whole of Canada in Earth Science Departments. The curve labelled BSc (Years 2-4) refers to the axis on the left-hand side and the curves labelled MSc and PhD refer to the axis on the right. The BSc data do not include first-year students because at most universities the undergraduates do not declare their intention to major in a particular program until the beginning of second year. In any given year the number of graduating students would typically be less than one third of the total enrolment in Years 2-4 (because of drop-outs).

For quite a long period through out the '70s and up to about 1981, undergraduate enrolment (the sum of 2nd, 3rd and 4th year of B.Sc. programs) maintained a relatively straight trend with annual fluctuations of about 10 percent. The average in the period 1974-75 to 1980-81 was 2643 students. In 1981 we entered into a brief period of rapid rise in enrolment. This was a crucial time in the market: it was a time when the petroleum industry suffered a major decline, and for much of that time the mineral industry has been focused on exploration for gold, financed by investment in the climate of flow-through tax incentives. It is somewhat ironic that enrolment started to rise when the job market was weak. Enrolment rose rapidly for three years and then started an even more precipitous decline. A small inflection in the downward trend was seen in 1987-88, and it appeared that enrolment would level out at the previous average. Unfortunately, the inflection turned out to be a ledge on the side of a very steep cliff. The numbers for 1988-89 showed a continuing steep decline down to a total of 1800 students across the country in the upper three years of the BSc programs. In the most recent two years (1989-90 and 1990-91), it appears that the downward trend has truly moderated. The total enrolment in Years 2-4 in 1990-91 was 1563 students.

Thus undergraduate enrolment has dropped to approximately 60 percent of the level of the long-term average through the 1970s, and this has some serious implications for the future. Given the present increase in exploration

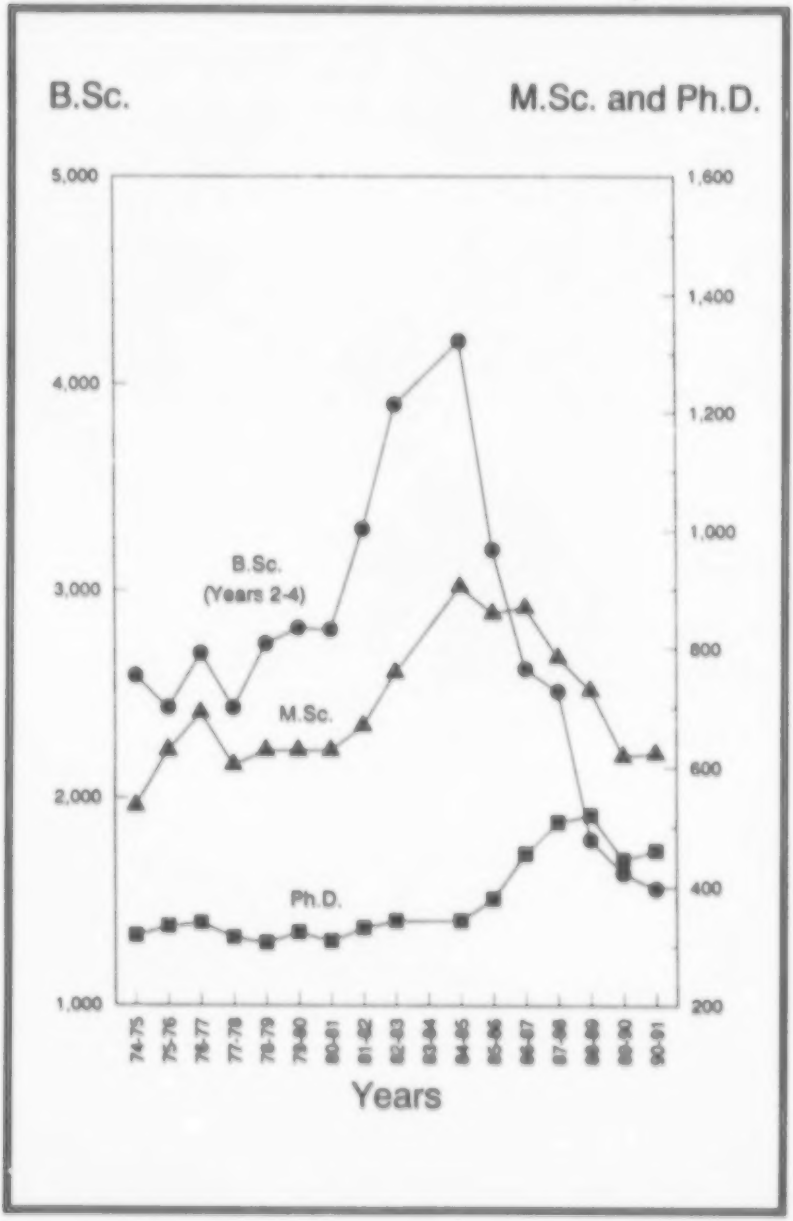
for base metals, greatly needed to rectify the low levels of reserves that have resulted from the recent focus on gold exploration, it seems likely that the industry will need to hire new BSc geologists and geophysicists at something like the long-term average rate. If this need does manifest itself, the supply will not be sufficient to meet the demand. It is perfectly valid to ask the question, "What is the appropriate level of supply of geologists for Canada?" No attempt will be made to answer this question here.

Another aspect, which is even more tragic, is that a large proportion of the students who comprised the bulge produced between 1981 and 1986 have now left the system. They graduated at a time when there were very few jobs: those who did not go on to graduate programs in geology have either taken MBA programs so that they can put their geological training to use in commodity analysis, investment or management, or they have left the industry entirely. Many have gone to teachers' college or law school. Therefore, this large number of "geologists" are not accessible; they are not likely to be available to help compensate for the personnel shortfall caused by the current low level of enrolment. Indeed, in the face of poor employment prospects, even some of the students who are currently in the system are making a decision to complete their degree but not to look for a job in the earth-science field because the ups and downs are too severe and they do not want to face the uncertainty of the current employment pattern. This is a crisis of major proportions: industry will have great difficulty in finding qualified and motivated geologists.

A further point of concern to the mineral industry is that while undergraduate enrolment is at an all-time low, so too is the proportion of undergraduates who are pursuing traditional "hard-rock" or mineral-exploration options. The balance has swung dramatically towards options with a focus on environmental geology or geotechnical engineering. The mineral industry will undoubtedly have a growing need for geologists with this training, but the need for explorationists is clearly not being met.

Figure 1 also shows that, at the same time as the undergraduate enrolment was rising, the enrolment in MSc programs started to rise also. This is a reflection of a weak employment market: many students who were graduating from baccalaureate programs didn't get jobs in industry, so they went back to graduate school. Three years later, in 1985-86, the PhD enrolment also started to increase. At first glance, one might interpret this as a reflection of a great increase of interest in research. Looking at it more cynically, and perhaps more realistically in hindsight, it too is an indication of bad times and students biding their time waiting for things to improve. At all three degree levels, the rise in enrolment has been followed by a decline, and the peaks at the three levels exhibit relative offsets in time that correspond to the average time for completion of the respective degrees.

Figure 1. Student registrations in Canadian earth science departments



In the last year, there is an indication that graduate enrolment is stabilizing at levels consistent with projections of the long-term trends, MSc enrolment of about 625 (the same as in the late 1970s) and PhD enrolment of about 450 (reflecting an upward trend consistent with other disciplines and in response to stated aims of federal and provincial governments). At the present time, visa students comprise 22 percent of MSc enrolment and 36 percent of PhD enrolment in geology departments, nationwide. Many of these individuals will return to their country of origin upon completion of their studies.

The proportion of graduate students who are engaged in study that is preparing them for careers in mineral exploration is still quite high. Data on the career objectives of current graduate students are not available, but the CCCESD survey includes a break-down by discipline and, of the total enrolment of 1075 students, some 450 are listed in "hard-rock" disciplines including economic geology, exploration geology and geophysics, structure and tectonics, and petrology.

One can read some short-term implications from this data set, assuming that industry will be looking for even a modest number of new staff. One is that the supply of baccalaureate graduates is going to be extremely tight in the next three years. The supply of doctoral candidates will be quite good in the next few years, because the current enrolment bulge will be graduating and will be in the market. The prospects for graduate schools are dim, however, for it will be very difficult to maintain the current level of graduate enrolment because the feedstock, the supply of undergraduates, is at an all-time low and we expect that industry hiring will absorb a large proportion of those, so that the number interested in going into graduate school may be much reduced.

One might well ask the reason for the precipitous drop in undergraduate enrolment since 1985. I don't think it is because of a change in attitude of students, turned off from field geology because they would get their fingernails dirty; rather, it is because the industry's activity declined, jobs were not available, and graduates weren't given the opportunity to get their fingernails dirty. Another contributing factor is the perception, reinforced by pronouncements by some government economists and politicians, that mining is a "sunset industry" with no long-term future in Canada. A third factor, in this age of "green", is the perception that mining is environmentally "dirty" and socially irresponsible. These factors all relate to the industry's public image, and the industry should make great efforts to address this.

The decline in exploration activity has occurred in both the mining and petroleum industries. Some petroleum companies have an excellent record of hiring through hard times. This has the advantage that the company can hire the very best individuals with little competition. Furthermore, it engenders company loyalty in the employee, and probably reduces the incidence of job-switching after the initial orientation period. Thus, a company can get greater benefit from its investment in training of the new staff member. There is

another difference between petroleum and mining: petroleum companies tend to hire more summer students, look them over, and then hire them permanently in bad times or good. On the other hand, the mining industry, at least in the exploration sector, has gone heavily to a system of hiring people on short-term contracts rather than making permanent offers. This pattern, which was encouraged by the flow-through share financing of exploration, has put a lot of instability into the employment picture. Graduates can't make it in the profession on three months of work in a year, so they give up. They may survive for a few years on that basis, in the hope that things will turn around and that the industry will go back to its former way of employing people which was to allow them to make a career. It hasn't yet happened.

There is a lag between changes in the marketplace and enrolment in universities. The geological profession has a history of cyclicity (and this cyclicity will likely persist), but those who are not yet involved may not be aware of this pattern. Many students are conditioned to a career choice in the later years of high school and when they make their choice at university they may not realize that the situation has changed; they don't necessarily look four years ahead. Enrolment tends to grow during rises in industry activity, and the growth persists for several years after a down-turn in industry begins. Enrolment then declines sharply. When industry recovers, the supply is low and cannot rise quickly, because it takes four years to produce a graduate. Thus, fluctuations in industry are inevitably mirrored in an exaggerated way in university enrolment.

Two approaches could theoretically help to dampen the fluctuations in enrolment. First, the universities and industry could work together to dampen the fluctuations by recruiting students into baccalaureate programs during periods when the market is poor, on the assumption that the market will recover. Second, and as an essential corollary, industry could try to maintain its staffing levels through the lean times. We must educate the pool of potential geologists about the cyclical nature of the industry profession: it is better to enter a geology program is when the job market is weak than when it is strong.

I would like to say something about the universities' role in personnel supply. The anomalous rise in enrolment in the early 1980s was an overreaction to a perception of increasing growth and excellent career prospects in geology and geophysics, mainly in the petroleum industry. One might suggest that if the universities had managed to stabilize enrolments, we would not have had the subsequent drop. However, there is no country-wide mechanism for limiting enrolment in the non-regulated professions. Medical schools, law schools and similar professional disciplines do limit their numbers, but by and large universities have a policy of not limiting enrolment in specific programs and so we take all the students who want to choose a particular field. In fact, Queen's does have a limit on the geology enrolment, instituted in 1982 at the

time that enrolment was rising rapidly, but we are probably one of the few departments that have a formal limit. The enrolment cycle is driven by market forces: the interest of the students and their perception of employment prospects; their perceptions about working conditions and career development. Therefore the image of the industrial sector is very important.

Now let's turn to the problems that the geology departments are facing at this time, as we try to increase the supply of personnel for the industry. It is well known that right now, and in fact over the last fifteen years, Canadian universities have been receiving declining funding in real terms from the provincial governments. This situation is particularly acute in Ontario, which ranks ninth among the ten provinces in per-student funding at the university level, and which produces over one third of the country's geologists. It is only natural that the universities will manage their internal affairs in the face of declining funding by putting pressures on departments which are perceived to have an anomalously high faculty/student ratio. This pressure has not yet translated into termination of academic staff, who are protected by tenure, although the recent announcement of the Nova Scotia government's intention to close three of that province's four geology departments could signal a new era for Canada's universities. The pressure does manifest itself in the collapse of faculty positions left vacant by retirements or resignations, to the great detriment of a department's ability to maintain a specialty, and it most definitely translates into budget cuts that affect operations. Maintenance and replacement of teaching equipment such as microscopes, computers and geophysical gear, the ability to take students out into the field for field trips, and the general quality of the program are being put under severe pressure at all Ontario universities at this time. Salaries (for faculty and support staff) typically account for more than 90 percent of the budget of an academic department; this leaves very little for operations, equipment and teaching assistants, and it is those categories which get further reduced when the university imposes a base-budget cut. Geology departments are in dire financial straits right now.

Obviously, one factor that attracts students to a career is the quality of the facilities that they will get to use during the undergraduate program and also the quality of the educational experience (which is affected by the morale of the faculty and staff in the department). These are being eroded.

In contrast, there is a reasonable level of funding of research. At Queen's, as at many other universities, the research funding is strong, and there is a good level of interaction with the mineral-exploration industry, involving collaboration and support of research and graduate study. However, in the next few years it may be difficult to continue this activity if the graduate-student enrolment declines because of the low rate of production of BSc graduates.

Thus the key to increasing the supply of personnel for the mining industry, the supply of geology graduates interested in post-graduate study and research, and the geology departments' share of university funding is to attract more students to geology programs at the undergraduate level.

There are two areas where industry can help to help stabilise the supply of geologists. First, the industry should try to provide a more stable employment environment, the opportunity for an employee to develop a career instead of employment in a series of three-month contracts. This may be hard on the quarterly balance sheet, for in the short term it is cheaper to have someone on contract than it is to make the permanent commitment; however, in the long run I find it hard to believe that it makes economic sense in terms of the total cost of recruiting and training staff and of losing the experience that each staff member gains in continuous work on on-going projects. Pity the new graduate who wants to work in the industry but has to face the cost of establishing a family in a major centre, because of the need for employment opportunity for the spouse, and can look forward only to a series of three-month contracts. That's not a good start for a career, and it is not a prospect that draws people to the exploration industry.

Second, industry could provide critically needed financial support to the geology departments. This kind of support will give the departments the flexibility that is needed to maintain and restore the quality of undergraduate programs, and to make these more attractive to potential students. As provincial funding continues to decline, universities are being forced to rely increasingly on private funding. The needs are in the areas of equipment renewal, support for field trips and field schools, scholarships (especially at the undergraduate level), and funding for new faculty positions (the cost of which can be shared through programs such as NSERC's Industrial Research Chair program and New Faculty Program). The need to increase the field experience in undergraduate programs can not be overemphasized, given that the opportunities for summer employment are less than they were in the 1970s. Many students graduate with less field experience in their undergraduate career than is the long-term norm.

The petroleum industry, in my experience, has a stronger record than mining companies of providing financial support for undergraduate programs. There are more undergraduate scholarships funded by petroleum companies, and there are more annual contributions which underwrite field trips and field schools than there are from the mining industry. For a relatively modest investment, a company can provide significant help to a geology department, to the direct benefit of the students, while raising the corporate profile. The mining industry should undertake to increase its support of geology departments with a view to increasing undergraduate enrolment and improving the quality of the programs.

In summary, the mineral exploration industry is facing a very severe shortage of personnel in the short term, because of anomalously low undergraduate enrolment in Canadian geology departments. At the same time, the geology programs are under pressure from the universities, because of the low enrolment, and in consequence, their quality is being eroded. The geology departments believe in the future of the mining industry. We want to be partners in the enterprise. The mineral industry can help restore the interest of young Canadian students in geology, especially mineral exploration, by undertaking to stabilize the industry's employment pattern so that graduates can look forward to a stable career. The mining industry should also undertake to increase its support of Canada's geology departments through the establishment of undergraduate scholarships and by providing financial contributions that will allow the departments to restore and improve the quality of their academic programs.

Industry-University Interaction

John R.M. Gordon

The minerals industry is facing a problem – a drastic decrease in the number of students choosing mining as their field of study. This problem is related to that of the cyclicality of the mining industry (a possible subtitle to this seminar). An additional concern is the level and quality of management education in the industry.

I would like to cover four main areas, addressing these problems from a business school perspective:

- management education;
- current issues facing management educators, both in and outside of industry;
- details regarding a 1985 Workshop dealing specifically with university-industry interaction;
- a case study of the Chaparral Steel Company as a model to follow.

Dr. Gordon is Professor and Former Dean of the School of Business at Queen's University, where he teaches and conducts research in the areas of strategic management, operations strategy, operations management, and the implementation of technology and flexible working conditions. He has developed and taught management development programs for Alcan, ITT, General Motors, IMEDE (Management Development Institute) in Switzerland, CNR, CCL, Nestlé, the Empire Financial Group, the Banff School of Advanced Management, the Dalhousie Executive Development Program and the University of Western Ontario, as well as serving on the boards of a number of Canadian companies. In 1984, he served as a one-man Commission investigating the Ontario Drug Benefit Plan for the Minister of Health, and subsequently as Chairman of the Fee Negotiating Committee for 1987-88. Professor Gordon is an engineering graduate of the University of British Columbia and holds an MBA from Queen's University and a doctorate from the Massachusetts Institute of Technology.

Management Education

We are not a cyclical industry in the area of management education in universities. Our growth in terms of enrolment has been very rapid. In Canada, we are now up to about 100,000 undergraduate students in the approximately 50 schools offering business education – close to 15 percent of the total undergraduate enrolment. In the U.S. where they are graduating over 60,000 students per year, that figure is 25 percent. I am not sure, however, whether all these MBA (Master of Business Administration) graduates are enjoying job satisfaction.

Of concern to industry is what I call a labelling dilemma in management education. Most people in MBA programs are more interested in management as opposed to business. The image of "business" is a four-letter word; "management" is something we prefer, i.e. dealing with people and getting things done through an organization.

MBA programs are very popular with many people in industry. When first started, the programs were viewed by engineers as a way in which they could "retread": in the 1950s, a significant number of engineers, finding themselves unskilled for the management positions in which they were placed after a few years in industry, returned to school to complete an MBA. Unfortunately, they then rarely returned to the minerals industry. We were not providing enough pure engineering jobs with enough challenge to keep their interest.

To its credit, management education has developed a number of programs in response to the needs of industry executives. The two-year Executive Master of Business Administration (EMBA) is geared to industry timetables. While continuing to work, industry executives study one day a week for 40 weeks per year. General management programs offer concentrated three- to six-week courses on the latest in management technology. There are also specialist programs providing instruction in areas such as the management of technology, project management, marketing, and finance.

The specialist programs are a very good bridge between the university and industry. Good contacts are developed, and if well done the programs can lead to research and to case work, and can be a major source of incremental funding for university schools of business.

In the area of research in business schools, there are two categories – theoretical research and applied research. Business schools are trying to walk a narrow line between being resident in a university that has high scholarly standards, and being applied, i.e. close to what is going on in practice. What develops is a spectrum of business schools across North America.

Case research, one facet of business school research, is a good example of good industry-university collaboration and liaison (even though some view this

simply as material for class discussion, not a contribution to the knowledge base).

Consulting is another way in which business schools can liaise closely with business; although, as with other professional schools, questions are often raised regarding its relevance to scholarly activities. If done properly, consulting can make a major contribution to bringing practice into the classroom.

Management development programs, what I would call in-house corporate programs, are also playing a positive role in university-industry interaction. Queen's School of Business, for example, has presented such courses as the management of technology and project management.

Sabbatical leaves also can help link these two sectors. In addition to being devoted to research, business school sabbaticals can also be very practical, providing a professor with corporate management experience.

Finally, all business schools, increasingly concerned with the global marketplace, are internationalizing their curricula. Exchanges with foreign professors and students are an important way of enriching our learning experiences.

Current Issues in Management Education

Technology: A Need to Develop Confidence/Appreciation

Management schools need to be concerned with technology, to counteract the technological aversion that exists in undergraduate programs. Many of the students entering the programs have had no mathematics or hard sciences since grade nine. But the management careers they seek often lead them into an uncomfortably (for them) technological environment. Although they may not necessarily need technical competence, they do need technical confidence.

Operations/Manufacturing: A Need to Overcome Traditional Aversion

The interests students have for manufacturing as a career is cyclical. In Canada, it is very difficult to get students interested in manufacturing. Careers in accounting, marketing, or investment are more attractive. The U.S., however, shows a significantly different trend, a much stronger awareness of the importance of manufacturing.

At Stanford University, for example, there is a voluntary club in manufacturing in which there are 350 students, a mix between business and engineering, who paid to be members. Their major activity is a trip every second year to places of interest such as Korea or Japan, to see what is going on in manufacturing. In off-years, the students organize a well-attended manufacturing conference.

The Service Sector: How Much is Too Much?

The large shift of employment to the service sector makes me nervous. It is not necessarily a true indicator of the importance of the economy, because the productivity differs significantly between the service and manufacturing sectors. The ultimate is an often-repeated quote: if we keep going on the same trajectory in terms of the service sector, pretty soon you and I will be selling insurance to each other. What is going to support that in terms of real value-added production? How much more increase in the service sector can our economy support?

Lifelong Learning: How Well Are We Doing?

Under this heading, I group continuing education, job readjustment, and also the recognition that we need more than the usual front-end loading education. In this changing world, we all must be prepared to update ourselves. The structure of lifelong learning, however, has not yet been fully thought through.

International Business, International Management

We need to distinguish between these two terms. International business is passively looking back at moving monies around, fuelling on the global economy. International management is dealing with different cultures, being able to manage no matter where you are located, being able to deal in different worlds. We, in management schools, have a real concern as to how to incorporate these two concepts in our curricula.

Environmental Sensitivity

Recently *The Economist* carried an ad from a European management school advertising for a Professor of Environmental Management, certainly an indication of the direction in which we are going. Students are looking for solutions and guidance and direction in the area of the environment. We need separate courses and research in this critical area.

Ethics

The whole concept of ethical thinking, of ethical business practices – both internal practices (dealing with employees) as well as external (dealing with customers) – must somehow be addressed in business schools. I am not sure you can teach ethics at a university, but at least you should be exposing students to ethical dilemmas, letting their consciences address the ethical situations that turn up when any sort of transaction takes place.

Rediscovering Some Human Resource Management Principles

Participative Management

Douglas McGregor at MIT introduced the theory of participative management, considered a bright new theory when I was studying business in the 1950s. But when we went out into industry, we didn't see any of it. Now, suddenly, a generation later, McGregor's theories have taken.

Cooperation vs. Confrontation

I think it is very enlightening, and very positive, to see what is going on in this area. There is a whole shift, a cultural shift, that is going on in industry, as evidenced by the willingness to set things out on the table. We, within business schools, are not prepared to handle how quickly this is happening.

Team Concept

With the appearance of many more teams in business, the question of compensation systems must be raised – of individual reward vs working together as a team, and how do you define the team.

Multiskilling – Job Enlargement

The idea of multiskilling comes out of the team concept, a theory that came out in the literature 20 years ago as "job enlargement". It is exciting to see that coming into practice.

Self-Management in the Flexible Organization

This is a term a colleague and I outlined in 1970. That concept of individualism, but inside an organization that's going to harvest energy, is today becoming much more prevalent.

Generation Theory

There is a theory that we are a generation "out of synch". In other words, the top of the organization is thinking one way, in terms of styles of management and working environment, and the entry-level employees are thinking a different way. Many companies have created focus groups, to sit down with new graduates and discuss what their expectations are. You really must worry about how to keep in touch with what's going on through the whole organization given the traditional hierarchy we have developed.

Strategic Alliances

One other issue is challenging us internationally, and this is something we refer to as strategic alliances. No longer are we thinking of restraining trade, but of cooperation; for example, cooperation between vendor and customer, management and labour. This transforms many "win/lose" situations into "win/win" situations.

A classic example from the management literature is the threat to Steinway Pianos from Yamaha. Yamaha, interested in Steinway's reputation and marketing skills, was moving in on the respected company. "How do we fight them?" was the question. But instead of fighting, Steinway decided to try talking to Yamaha, to find out if there was a way both companies could benefit from each others' strengths.

This type of strategic alliance is becoming more common. Even the government is making more arrangements rather than taking an adversarial stance.

Industry/University Interaction

In Canada, the relationship between industry and universities is certainly different than in some other environments. We have something to learn regarding cooperation between these two sectors from Japan, the U.S. and in Europe.

National Workshop on Management and Technology

This workshop was held in January 1985 in Montreal, because we felt there was a real void in the area of management and technology. Ninety participants attended, divided equally between industry, engineering faculties, and business schools from across Canada. We had assistance for the workshop from NSERC, the Science Council, and the Corporate Higher Education Forum. Keynote speakers included David Vice, Northern Telecom; Doug Wright, Waterloo University; and Hugh Wynne-Edwards, former Chief Scientific Officer for Alcan International.

We were looking for the interface between industry and university, between management and technology (*not* management *of* technology), and between faculties of engineering and faculties of business. After 2½ days we tabled 50 initiatives, broke off into groups, and decided who would have responsibility for each initiative. We also decided to hold a follow-up meeting in 1988.

A Sampling of the Workshop Initiatives (Relating to this Seminar)

- *Technology for the non-technologists*
  We are not doing a good enough job in our undergraduate programs, to say nothing of what is going on in high schools.

- *Cross-representation on advisory councils*
  Queen's University has advisory councils for the faculties of engineering and business. Why not organize exchanges between the two councils to stimulate some cross-fertilization between the two faculties? Most universities, certainly in Canada, do not encourage any links between faculties.

- *Faculty on boards of directors*
  Faculty members should be on more boards of directors of corporations – a standard procedure in the U.S. I see the Royal Trust of Canada putting a faculty member from the Harvard Business School on their board, but little evidence of Canadian faculty involved in Canadian business. This would be a great way to address certain issues.

- *Broaden admission criteria*
  When I find, for instance, over a 10-year period, that the Commerce faculty has raised its admission standards for grade 13 graduates from 78 percent to 87 percent, I get nervous. Is that the most appropriate screening? Should we be looking for students only by marks?

- *Industrial engineering*
  We are doing precious little in Canada about industrial engineering. There is a big void here.

- *Engineering in management*
  We have already talked about putting more engineering in management, and more management into engineering.

- *Cross-appointments*
  Often talked about as a good idea but rarely performed.

- *Science and mathematics in high school*
  According to a *Globe & Mail* article by the Queen's Dean of the Faculty of Education, people who go into high school teaching careers, are coming mostly out of the social sciences and humanities. They do not have a background in hard sciences or mathematics, and, after one year in teachers college, are asked to teach these subjects. So many of the young people are much more technologically oriented, but they unfortunately are running into unenthusiastic teachers.

- *Faculty visits to industrial sites*

- *Case development – technology*
  Queen's School of Business uses a fair number of cases that have quite a technological content. This is a good experience, and we should have more of those cases. Industry can certainly help in this area.

- *Exchange programs – faculty in industry*

- *Industrial liaison positions in universities*
  Over the last five years at Queen's, we have been able to develop an arm's length relationship with an organization in the university whose primary task is to commercialize university inventions. That is acting as a bridge between the university and industry, with a business-like relationship.

- *Student projects in industry*
  Cooperative programs are a good example.

- *Joint research projects between engineering and business*
  A good idea that seldom is carried out.

- *Transfer of technology – both ways*

- *More emphasis on manufacturing management*
  and on manufacturing engineering. Industry is doing well in the areas of design and analysis, but not in how the item is made.

- *Investment in human capital needed – all levels*

- *Five-year degrees in engineering management*
  McMaster has led the way in this area, putting engineering and management together. The University of Toronto did have a four-year business engineering degree, which unfortunately was cut by accreditation standards, in spite of its popularity.

- *Contract R&D*
  This is occurring, but not often enough.

- *Networking – industry/university*

- *Continuing education directed at industry needs*
  Dialogue between university and industry needs to be improved. The university has skills that could help industry. Universities in the U.S. have been more adept at being more "consumer oriented" in their programs. Such programs are also a way to bring in additional funds to the university.

- *More field trips*
  University faculty members should be visiting plant sites. For example, last year I spent 10 days on the road with a group of Stanford University students and faculty members, touring a paper mill and locomotive plant, and visiting companies such as Honda, Ford, Whirlpool, and Timpkin,

speaking to union people as well as to executives. The students gave up their Easter break and $1500 out of their own pockets to take the tour (money which they got back through donations from the companies as a result of the reports the students prepared on each company).

- *Cross registration*

- *University consulting seen as positive*
  Good, high-quality consulting with industry is very important. In this way professional schools keep in touch with what is going on. They are able to bring their skills, but also are at the same time held up to the demands of time pressures, credibility, and writing reports that make sense.

- *Government support interaction*
  During the workshop, we were able to put pressure on NSERC. The very positive result was industry-NSERC sponsored chairs in management and technology.

- *Research in the management of technology*

The Follow-Up in 1988

During the Montreal workshop, we had agreed to meet two years later for a follow-up session in Edmonton. Everyone who had signed one of the initiatives was responsible for a report. The most positive account came from Tom Hennebury, who was able to describe what Northern Telecom was doing in the area of human resources.

Chaparral Steel Company - A Case Study

I have taken the Chaparral Steel Co. in Midlothian, Texas, as an example of what is being done in a particular company. Chaparral is a sister company to Lake Ontario Steel in Whitby - a Canadian initiative in what I consider to be a very positive way of dealing with labour management. It is not perfect, but is a good example of what can be done in an industry that does face some cyclicality, is a primary industry, and has a relatively traditional focus on technology (perhaps even an outdated technology).

Chaparral was founded, in 1973, on a new technology coming into a traditional environment. The new technology was based on the mini-mill, electric arc furnace, and continuous casting. It was a greenfield site, and came

on line in 1975. The original capacity was 250 tpy, and the company originally had 500 employees. By 1979, they were operating at a profit.

In that year, they decided to double the plant's capacity, which Chaparral accomplished by 1981 with 900 employees. In 1984 this company was rated by Fortune Magazine as one of the ten best-managed factories in the U.S.; four years later, the President (who had taken a minor in management with Douglas McGregor) was named CEO of the Year by Tom Peters; in 1989 his VP of Quality Control was named a Fellow of the American Society of Metals and the company was awarded a Japanese industrial standard.

Chaparral is now producing 1.5 million tons with the same equipment that was initially rated for 500,000 tons. Last year they started shipping steel to Japan, the U.S.S.R. and South Africa. All this was accomplished with some innovative human resource strategies, some of which may sound rather magical.

Some Human Resource Aspects

One of the principles is participative management. "Decision making in this organization is pushed to the lowest competent level, making the lowest level competent." In addition to getting everyone involved in decision making, this also shows a commitment to training and developing people.

Employees work on a profit-sharing basis based on bonus and stock ownership plans. Everybody in the plant is an owner. There are no layoffs, even during the low years of the steel industry.

The company's training program is also of interest. Chaparral rotates the line workers through training assignments for two years. They then become trainers themselves as part of their total job responsibility.

Company organization is a flat structure, down to four levels of management, with the CEO as the fourth level – and everyone has the same colour of hard hats. The theory of cooperation rather than confrontation is practised wherever possible, with vendors and employees. Chaparral is also fully dedicated to teams and multiskilling. At the same time, they differentiate very specifically between the different areas in the plant and the skills required in each. Task forces – groups of employees from all levels – are used whenever changes need to be implemented; for example, to computerize an activity.

Compensation is directly related to skills required, not to seniority, and everybody is a salaried employee – no hourly paid workers. Employees can apply for a sabbatical, regardless of their position in the plant. The sabbatical can range from one month to the time required for a university degree.

Chaparral promotes what is referred to around the plant as the "CEO's classless society". Everyone has access to free coffee, and there is no reserved

parking. The company works to promote an environment of fun, encouraging laughter in the halls, and of experimentation on the floor – but "don't make the same mistake twice."

Some say the organization is an interesting combination of leadership, communication, and positive feedback, all blended in a positive way. Chaparral's management values can be summarized as follows:

- Trust and responsibility
- Risk and curiosity
- Knowledge and expertise
- Networking and information exchange
- Humour and humility

Chaparral is very open in industry/university collaboration. I was able to observe the company for a number of years. Another example is the metallurgist there on a sabbatical for one year. Chaparral paid his salary and expenses, but at the same time increased its yield by one half a percent.

And that's my message. Industries and universities, in today's tough business world, should work together.

Mining Managers: Born or Developed?

Peter R. Richardson

Introduction

While many people recognize the outstanding contributions of Socrates and Cardinal Newman to the philosophy and practice of education, few people have heard of Benjamin Jowett, Master of Balliol College from 1870 to 1893. Jowett developed an educative process which prepared the great young minds of England to lead and administer an Empire that spanned six continents. His teachings recognized the crucial importance of working with disciplined regularity, of thinking independently, and of balancing social, economic and political forces.

The Canadian mining industry, which also has a presence on six continents, has not benefited from a similarly gifted vision of management education. Education for a career in mining has generally been viewed as either technical in nature or best learned through experience. In contrast to Jowett's emphasis on breadth, balance and independent thought, mining management has more been characterized by narrow vision, by lack of a long-run perspective, and by regimented conformity.

These traditional attitudes are changing, as more executives in the mining industry have some degree of formal business education. However, management education has still not reached the strategic agenda of most mining corporations. Rather, it is viewed as a luxury to be undertaken on an ad-hoc basis, as and when funds are available.

A graduate in electrical engineering from the University of Leeds with a PhD in business administration from the University of Western Ontario, Professor Richardson currently teaches in the School of Business at Queen's University, in the areas of business policy, strategic management, mineral economics and management, and management of technology. He maintains an extensive connection with industry, working with firms such as Falconbridge Limited and Noranda Inc. (with the Chairmen and senior executives, formulating and implementing corporate strategy and cost-management programs), and Alcan International (management development activities in the R & D and engineering organizations). Dr. Richardson has an impressive list of publications, including a recent book, Cost Containment: The Ultimate Advantage. In addition, he is active in various continuing education activities, such as leadership seminars for Alcan Limited and Polysar Limited and the Queen's Executive Program.

The facts bear out this view. Most mining companies have no formal management development plan. They typically spend less than one half of one percent of revenues on all aspects of training and development, and only a fraction of this amount on management education. Human resource and training groups have been decimated by staff cuts in the last ten years at many operations. Illustrative of this neglect, industry journals dominated by technical papers, rarely carry articles on new management developments in the industry. Corporations, with strong links to mining schools, have failed to impart the need for graduates to have a knowledge of basic managerial techniques and skills as well as a strong technical base.

During the last twelve years, I have been directly involved with some form of management education for between ten and twenty thousand people in the mining industry. This experience has encompassed the education of senior executives about strategic planning and human resource strategies, seminars with shop-floor employees on cost management, team building and even corporate strategy, as well as individual coaching either on the shop-floor or in the office.

In this period, I have viewed myself as playing a unique role in the organizations that I have worked with, that of an educational executive. Although, in this role, I have frequently taken part in making strategic and operational decisions, my primary role, in any situation, has been to make employees think for themselves, challenge conventional wisdom, and make creative and innovative decisions.

In my talk today, I will address the subject of management education in the mining industry. I view this process as taking place only partly in the formal surroundings of a classroom or seminar, partly in the workplace, and certainly on the job. Please note the important distinction that I will draw between management education and training. There is of course a subtle, but significant, difference between the two.

Is Management Education Effective in This Industry?

There are still executives in the mining industry who doubt the value of investments in management education. These individuals believe that managerial and supervisory technical competence can outweigh a lack of managerial and leadership qualities. For example, they question the relevance of strategic planning techniques in an industry as uncertain and cyclical as mining. They cite management courses given by their corporations that have provided little apparent benefit or value creation afterwards.

My response to these people, when I meet them, is that the outcome of management education, as with most aspects of corporate life, is determined

not so much by what is done as how it is done. There are now lots of expensive "fad" management courses which create little value. Employees sent to an external management course and then returned back to the workplace with little or no follow-up and support will rapidly forget what they learned. Wholesale adoption of "canned" programs offered by consultants are likely to create little value. In-house courses led by individuals who have been "shelved" as low-performers in line positions will be perceived by participants to have little credibility or value.

Rather, management education has to be put into a strategic and operational perspective. Educational activities that are an integral part of a corporate strategic thrust are likely to be perceived as useful and acted upon. Seminars and courses that are tailored to meet specific corporate requirements will be seen to be relevant. Structured follow-up workplace experiences that reinforce the content of formal sessions are important. Allowing work-groups to share the same educational experience can be used jointly for both team-building and problem-solving.

During the past ten years, I have experienced how successful these approaches can be. I have been involved in strategic management seminars given as part of the implementation of a strategic planning process. Project leadership seminars involving employees from both the Technical Centre (R&D) and business units have been used to support innovation strategies. Seminars on cost management, managing change, communication skills and leadership have been successfully used as integral parts of cost-reduction strategies by corporations with which I have worked.

Given the relatively capital-intensive nature of mining, "every employee a manager" should be a catch-phrase for the industry. In a modern operation, a mine captain or shift boss is really an operations manager running a business in which tens of millions of dollars are invested, and using the skills of many highly trained and expensive individuals. Shop-floor employees are directly responsible for sophisticated capital equipment, and poor operating decisions can perhaps cost a corporation substantial amounts in lost revenues. However, in most mining corporations, management education provided for these employees is minimal, because of what I view as the "class system" in the industry.

The Class System in Mining

In most mining operations there are two classes of society: the professionals, with either a scientific or engineering degree, and the rest. Employees joining the organization as professionals are automatically provided with the option of a management career for those so inclined. Nowadays, most professionals

making this choice will be provided with some sort of formal management education, although most likely it will not be well planned or structured.

For an individual to jump the gap between the ranks of operators and supervision to management is extremely rare. The "best" a bright person joining the industry without a degree can usually hope for is to rise to the level of Mine Captain, Shift Boss or General Foreman. These very terms, still used in most mines in this country, speak volumes about the industry's attitude to organization, culture and gender. Mining is one of the last industrial bastions of regimented organization and male dominance, and the walls are being breached terribly slowly and only with great effort.

This sense of "class" predetermines attitudes to education. The workforce in most mining companies is usually subject to "training", not education. The implication of this differentiation is that the workforce is being asked to do and not think. Courses are predominantly related to task performance, rather than communication, problem-solving, team-work and other social skills and techniques.

These management attitudes encompass supervisors, who frequently find themselves as the filling in the sandwich between management and the workforce. Supervisory training in most mining organizations is limited and, where it is carried out, it is too often done on a minimal budget, of low quality, and lacking in relevance.

Mining corporations are managed, but too frequently they are neither well managed nor well led. They make money only when prices are high. How much they make and for how long depends more on the quality of their orebodies than the quality of management. Many mining executives are totally ignorant of any concept of marketing, plan poorly and are prone to accept conventional industry wisdom as reality. Hence, it is a rare executive who is creative or bold enough to make countercyclical investment decisions (although I should note in passing that financial management is one area in which mining executives have typically been extremely creative and innovative).

Paradoxically, the major education problem is generally not now at the top of most mining corporations, but among the ranks of middle management and supervision. Senior executives often possess management qualifications and attend seminars on modern practices such as strategic planning and financial management. Quite a number of senior operations managers also possess business qualifications in addition to their technical degrees. However, they have not provided lower-level managers and supervisors with the same opportunities.

Changes in the Last Decade

Many people believe that the industry changed fundamentally after the price and profit depression of the early 1980s. Corporations such as Inco started to pay much more attention to innovation and technology. Companies, led by Alcan and Noranda, increased their budgets for product development and put real effort into making industry associations like the International Lead Zinc Research Organization and the Nickel Development Institute work. Others, like Falconbridge, started to improve relationships with their workforce through much-improved communication and involvement programs.

At the same time, however, industry employment was cut back severely. In particular, management and staff groups were reduced in size. In addition, discretionary spending was curtailed. On occasion, this really did mean that the corporate jet and the limousines were sold. Frequently, however, it meant cuts in exploration, capital investment and management development and education.

During the last two years, increased prices and profits in some segments of the industry have meant that spending on management development has increased. Corporations are starting to develop succession plans to address the gaps developing in the managerial ranks. Increasing numbers of employees are being sent away to courses. In-house development programs, often tied to themes such as "excellence", "quality improvement", and "the management of change", are being instituted.

So What's the Problem?

There are, in fact, five continuing problems that the industry has to cope with in this area which limit the quantity, quality and effectiveness of management education.

First, although they are educated in management techniques, too many executives are incapable of challenging the attitudinal status quo in the industry and their organizations. Traditional beliefs and values among managers and supervisors towards the business, the organization and ways of working are extremely hard to change, especially in the remote geographic areas, away from the main-stream of management thought, in which mining tends to be carried out. Few management educators reach into these communities and often, senior executives don't spend a lot of time there.

Second, executives still lack a vision of what can be accomplished by a well-educated and motivated mining workforce. Few mining executives are aware of the value that can be created for the corporation by a workforce working as a team that shares problems and contributes to low-cost solutions. For

most executives, employee involvement remains an idealist's dream that doesn't pay its way. Union negotiations and conflict management are still their hard reality.

Third, executives lack the skills to successfully implement the necessary changes. While mining executives are receiving management education, the focus tends to be on accounting, finance, operations and marketing. Few are obtaining skills that enable them to effectively innovate and create organizational change. Courses designed for the mineral industry on strategic management, innovation, managing change, and effective communication are still not widely available.

Fourth, the cyclical nature of the industry frequently derails initiatives that are undertaken. The relatively short duration of periods of prosperity means that funding for many management development programs disappears after only one or two years. Worse, the credibility of initiatives taken with the workforce during good times is lost when the market turns down and executives resort to a traditional management style, usually involving layoffs.

Fifth, as noted at the outset, management education has yet to be put on the strategic agenda of the industry and most of its players. While the industry has come together to develop a joint, if still imperfect and fragmented, strategy for technology, industry-wide initiatives for management education are lacking. Most corporations lack a strategy in this area. As a result, potentially valuable joint initiatives are not happening, and universities are not receiving the guidance and advice required to produce graduates with the appropriate mix of technical and managerial learning.

Pre-Employment Management Education

Before attempting to suggest solutions to these problems, it is necessary to define what the management education possibilities are for the mining industry. The mining industry can realistically expect to have some influence over the management content of professional employees through input to university and college curricula. However, for other employees, management education needs can only be defined once they are employed.

A first challenge for the mining industry is to define what management education is required by scientists, engineers and other professional staff during their university or college programs. Currently, most scientific and engineering curricula contain little, if any, practical management content.

Most university engineering programs include a course typically titled "Engineering Economics" approved by the Canadian Accreditation Board which covers basic supply and demand theory, economic analysis, and some rudiments of production management. However, other than this course, most

engineers receive little education in the modern management practices essential to the effective operation of a modern mining facility. For example, at Queen's University the only management options listed for mining undergraduates are "Management and Human Resources" and "Business Organizations in the Mining Industry".

Many engineers, recognizing these deficiencies, often return to university and take a Master's degree in Business Administration (MBA), but then frequently move on to careers either outside the industry or in a corporate office, rather than operations. This trend is reinforced by mining companies themselves who either ignore MBAs in their recruitment activities, or hire them for marketing and fiance positions. Few MBAs are hired directly back into operating roles, primarily because mining companies have failed to develop a "fast-track" program for career development.

In-Company Management Education Possibilities

In a modern mining enterprise, all types of employee require some form of management education in addition to the traditional finance, accounting and production disciplines. Executives have to be familiar with the key elements of strategic management, which today includes business planning, global competitive strategy, international business, marketing strategy, building corporate culture, and human resources strategy.

Operating managers and professional employees require some of the same knowledge and skills to be able to participate in strategic planning and decision-making, but require additional knowledge of operations strategy, managing innovation and change, cost management, team building and communications strategy.

Today, to be truly competitive, mining corporations have to be prepared to provide similar education opportunities to supervisors, operators, clerical and technical staff. At these levels, training in practical cost management, managing change, communications, quality control and problem-solving is essential if they are to create real value for the corporation.

Management education can take place in a variety of formats after the employee joins the corporation, through

- external short courses provided by universities, colleges and consultants;
- in-company development courses;
- a return to part-time or full-time post-graduate education (typically an MBA);
- on-the-job specific learning assignments; or
- one-on-one coaching by mentors.

Few corporations have a focused strategy that integrates these different vehicles into a comprehensive management education strategy. Even fewer tie such a strategy into an overall corporate strategy aimed at maximising competitiveness and financial returns. Very few link education to specific strategic and operational initiatives in such a manner that the learning is reinforced on the job.

At present, management education in the industry is carried out primarily by sending managerial and professional employees to short management courses offered by universities and consultants. For the most part, these are not tailored to the specific needs of the industry, and participants often find it hard to relate their experiences to examples used on the course and still harder to apply the learning on their return to the workplace.

Some companies have developed in-house management development courses tailored to their own specific needs. These programs can be designed to provide a powerful mix of general learning, company-specific knowledge and team-building. Alcan has for some years had an International Managers Program focused on the needs of junior executives. Falconbridge has developed a two-week Management Development Program around strategic management concepts. Relatively little has been done in this respect, however, among supervisory and operating personnel, where there is great potential for significant gains to be made.

Mining companies have made little effort to encourage promising employees to return full-time to take an MBA. In most mining companies, a leave of absence is the most that employees making this decision can expect to receive. Consequently, many fail to return to their original employer upon graduation. Novel strategies to provide an incentive to return, recently implemented in other industries such as consulting, could be effective in this area.

Most mining corporations have made some use of organized on-the-job management development, but several deficiencies are apparent in the industry's approach. One major shortcoming is the apparent unwillingness to rotate employees through a variety of jobs and assignments, especially in more senior roles. Line and staff personnel switch roles only infrequently; in a corporation such as IBM, the normal expectation is for a professional employee to spend periods of several years alternating between these types of roles. In addition, personnel are not moved among operations frequently (compared, say, to banking, where managers relocate every four or five years).

Individual coaching or one-on-one mentoring is carried out informally in most organizations, but few have specific mentoring programs designed to develop the professional and managerial talents of new employees.

How Can the Problem Be Tackled?

There is little likelihood that industry executives are suddenly going to arrive at the realization that they have been seriously underinvesting in management education. My belief is that most executives still don't realize that they have a problem in this area, and that no major changes will occur without some external stimulus.

Providing examples for them of what firms are doing in other industries is useful, but these alone will not change strongly held attitudes. For example, Dupont Canada invests an amount equal to approximately seven percent of its employee payroll on employee training and development. Approximately half of this amount is for managerial and business eduction for its entire workforce. General Electric Corporation has a Management Institute with a budget larger than that of the largest Canadian universities. However, when such facts are pointed out to them, mining executives respond that "the situation is different in our industry".

Starting at the beginning of the education chain by introducing management education into university and college engineering undergraduate programs holds long-run promise. However, many Faculties of Engineering still remain to be convinced that such courses are an integral part of their curricula. Moreover, even where such courses should be introduced, there is an acute shortage of qualified faculty to teach them.

In my opinion, improving the quality and quantity of management education in the mining industry will be a long and challenging task. When it comes to investing in this type of activity, many senior executives simply don't want to know. They will go on throwing money into capital investment, starving the human resource system, and wondering why their organization fails to perform to their expectations.

Hope does lie, however, with more open-minded executives, particularly those moving into minerals from other industries where a high level of management development activity is usual. A short-term challenge for us is to identify these individuals and establish an effective dialogue on industry needs and possible initiatives. In addition, there is a need to publicize the successful initiatives that they take, so that others in the industry can imitate their success.

With this situation in mind, I shall frame my proposals in the form of three questions:

- What's needed in the industry?
- What would I like see happen?
- How to proceed in the short term?

What's Needed in the Industry

There is a need for a wide variety of management education for all types of employee in the mineral industry. As stated earlier, my belief is that, for firms to be maximally competitive, "every employee must be a manager". Therefore, every employee needs some form of management training.

Let's take for granted the provision of functional management skills, such as accounting, finance and marketing which have traditionally been available within the industry, and consider relevant areas of management expertise required by different types of employee. Figure 1 lists the kinds of management skills required by executives, operating managers, professional staff, supervisors and operators.

There is an overlap of subjects among the different groups, but different levels of sophistication are required. For example, the business planning skills required by senior executives are likely to be more sophisticated than those required by professional staff. Ideally, these skills should be developed before they are actually required on the job, as part of a continuing employee development and succession program.

What Would I Like to See Happen?

Within the Industry:
Executives in the mining industry should develop greater cooperation between corporations on management education. Important priorities are

- increased spending on management education;
- corporations working together to develop and conduct joint management development seminars and exchanging employees on "action-learning" programs;
- a Management Committee as part of the CIM, distinct from the Mineral Economics Committee and the Education Committee;
- a network of executives sharing their initiatives, successes and failures.

Within Corporations:
Corporations must start to act much more thoughtfully and creatively on management education, as an integral part of a comprehensive human resources strategy. Senior executives should devote at least one or two days each year to reviewing and planning these activities with their line managers and human resource staffs. The following initiatives should be considered:

Figure 1. Management skills inventory

EXECUTIVES

- Business planning
- Media handling
- Management of change
- Technology management
- Communication skills
- International business
- Government relations
- Human resource management

OPERATING MANAGERS

- Business planning
- Quality management
- Management of change
- Operations management
- Communication skills
- Media handling
- Cost management
- Negotiations strategy
- Supplier management
- Team-building

PROFESSIONAL STAFF

- Strategic management
- Project management
- Presentation skills
- Financial analysis
- Technology management
- Team building

SUPERVISORS

- Cost management
- Communications skills
- Leadership styles
- Basic business skills
- Quality management
- Team-building
- Problem-solving

OPERATORS

- Cost management
- Communications skills
- Basic business skills
- Problem-solving
- Team-work skills

- comprehensive management education strategies across all categories of employee;
- recognition of the role of management education consultants or such-like in all major mining corporations;
- more frequent movement of employees to other jobs and other operations within the same corporate group;
- more management courses developed to support strategic or operational initiatives;
- more seminars with on-the-job action-learning and follow-up components;
- much more management training of supervisors and operators;
- more funding of employee visits to companies in other industries to study management development initiatives.

Between Industry and Universities:
Much closer cooperation needs to be developed between industry and the universities, especially on curricula for engineering programs and on increasing the number of mineral industry-specific management continuing education courses available. Specific actions include

- university-industry cooperation and dialogue on management courses in engineering programs;
- universities developing more courses and materials targeted at the minerals sector, with industry funding for these activities;
- more corporate support for employees returning for full-time management education, coupled with incentives to return to the company upon graduation.

How to Proceed in the Short Term?

In the short run, progress needs to be made in all three directions: within the industry, inside corporations and with the universities. A first priority must be to ensure that senior executives in mining corporations are aware of the importance of management education, the scope of the challenge and what can be done. In my experience, the best way to accomplish this task is to involve them in management development activities, either as speakers or participants.

The visibility of management education within the mining industry has to be raised. The creation of a committee within the CIM primarily concerned with management issues and education (as distinct from economic and technical matters) would be an important first step in this direction. This committee could then maintain the profile of the area by ensuring that management sessions are an integral part of all future CIM conferences.

The profile of management education could also be raised by developing a set of joint management development programs for the industry. Currently, only McGill University offers a series of specialized management courses for the industry. Possibly the Mining Association of Canada could establish a task force to examine the possibility of establishing a series of high-quality continuing management education programs in Canada.

Finally, industry executives have to work with the engineering faculties in Canadian universities to help define the management knowledge that they believe graduating applied science students should possess. Change to university curricula comes slowly, especially where accreditation boards have substantial influence. However, there is little doubt that change will come much more quickly if the Canadian mining industry gets involved.

Continuing Education Programmes in Mining Schools

Odwyn Jones

Introduction

In the Third Century before Christ, Diogenes said that the foundation of every State is the education of its youth and I am sure no one would wish to argue with the validity of that statement. Today, we would have to go further and say that the competitiveness of any industrialized nation will increasingly depend on the effectiveness of its continuing education and training. Let us therefore look briefly at the education and training programmes.

Japan has been described as a homogeneous classless society with a high general standard of education, especially in mathematics where about 30 percent of school-leavers continue into higher education with one-fifth to one-quarter of these enroling in engineering courses. All engineering recruits are given a short induction course before joining the workforce. Career planning and personal development of employees are given great attention, and most training is on-the-job. It appears, as well, that self-development through private study is also greatly encouraged.

In the United States, it is interesting to note that engineering is attractive to young people even though they may not practice their profession in later life. Consequently, it can be said that many young Americans view engineering education as good preparation for life. Americans also appear to place great importance on continuing education, and employers strongly support the personal development of engineers.

Professor Jones was born in Wales and started his education in mining engineering with an industry-sponsored scholarship to the University of Wales in Cardiff. After receiving his doctorate from Glasgow University, he taught for 13 years at Strathclyde University and then held two posts in the polytechnic sector in the U.K. In 1976, he moved to Australia to take up the position of Principal and Dean of the Western Australan School of Mines. In that capacity, he is very active in the development of curricula and courses in both Australia and the Far East, and has made many changes which have resulted in an innovative approach to mining eduction.

In West Germany, most entrants to the engineering profession follow the conventional route from secondary school into higher education, and the system produces two types of engineers: the IngGrad who follows a practically oriented 3-to-4 year course at a Fachhochschule and the DipIng who takes a 5-to-6 year course at a Technische Universität or a Technische Hochschule. A smaller proportion pursue their apprenticeship before re-entering full-time education in order to qualify as an engineer. It is also noteworthy that senior managers of industry tend to be engineers and that the majority of board members of German companies have engineering backgrounds. Training and continuing education tend to be provided in-house by the larger companies whilst the smaller and medium-sized companies tend to make use of external agencies.

In my own country, the education and training of engineers extend for a period of seven years or so and involve attending a university or institute of higher education to obtain a Bachelor's degree in Engineering and the completion of a satisfactory programme of on-the-job training. Continuing education and training are supported by most mining companies on an ad-hoc basis with the larger companies organizing many in-house programmes.

A major change is currently taking place in the higher education scene in Australia. The number of universities is being expanded from the pre-1987 figure of 19 to 36 and the binary system of higher education is being discontinued. A *unified national system* is currently being established whereby all 36 universities will be funded on a triennial basis according to their educational profiles. Consequently, universities are becoming more accountable for their actions since their performance can be compared with their stated goals and objectives as defined in their educational profile.

The recently published *White Paper* states that *"all Australians expect and deserve an equal chance to succeed in life with positive assistance given where necessary to make up for financial, or other, disadvantages."* It goes on to say that *"access to education is vital since it is one of the principal means for individuals to achieve independence, economic advancement and personal growth."*

It also states that *"the society Australians want cannot be achieved without a strong economic base"* and that *"industry is increasingly faced with rapidly changing international markets in which success depends on, among other things, the conceptual, creative and technical skills of the labour force, the ability to innovate and be entrepreneurial."*

The Need for Continuing Education and Training

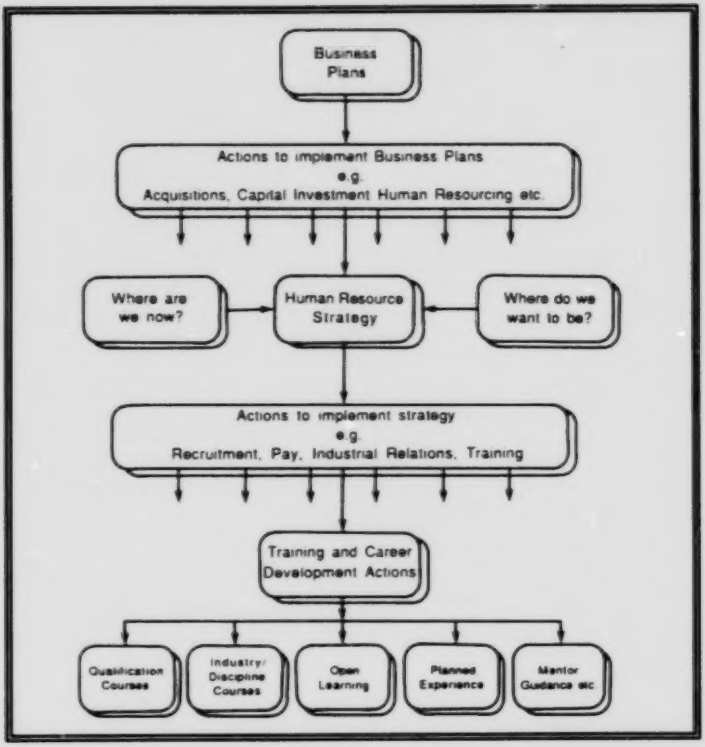
We all know that the body of engineering and technological knowledge is rapidly expanding and that computers are having a dramatic impact on the practice of engineering. Problems considered insoluble a decade or so ago can now be handled routinely by the use of computers. Despite this expansion in the knowledge base and problem-solving capabilities of engineers and technologists, there is a need to increase the managerial, entrepreneurial and communicative skills of engineers, and these topics are becoming integrated in many of our 4-year undergraduate courses. Consequently, our degree courses are becoming more biased towards design and development with increasing emphasis being placed on the use of computers.

We will also see more combined first degrees being introduced, linking engineering and earth science courses with business studies.

Those who graduate from our universities this year could still be practising their profession in 2030. Due to the increasing pace of scientific and technological advances, it is no longer possible for individuals to keep pace with technological change by dint of their own efforts and scholarship. Consequently, continuing education and training are becoming an essential part of an engineer's personal and professional development.

In a paper entitled *"A Call to Action"* published in 1986, the Engineering Council in the United Kingdom presented the case for a radical change in attitudes towards Continuing Education & Training (CET) for engineers and technicians in order to improve industrial competitiveness. Subsequently a National System for CET was proposed and a number of pilot studies were commenced in 1988 with the aim of developing a comprehensive approach to CET for engineers and technicians. The needs of the individual for continuing education and training can be met by a variety of methods, including open learning, in-house training, work experience, and short courses. The justification for this structured approach to continuing education and training is based on the fact that the U.K. is falling behind its industrial competitors and a realization that to remain competitive in world markets, employers need engineers and technicians who are up-to-date in their knowledge and skills and are able to help their employers improve their competitive edge.

Figure 1 indicates how employers can plan their skills requirements.



Another feature of the new system proposed by the UK Engineering Council is the involvement of individual engineers and technicians in preparing their own Career Action Plans (CAP) as shown in Figure 2. In doing so, they will work through a diagnostic process illustrated in Figure 3, and it is anticipated that the approved CAP programmes will be the blueprint for the individual's career development for the next five years.

Following are the main elements in the Continuing Education & Training programme proposed by the UK Engineering Council Working Party:

Learning Aims

To improve current and future performance
To improve learning from current work
To prepare for future change of technology and job
To assist in personal development

Figure 2. Career Action Plans

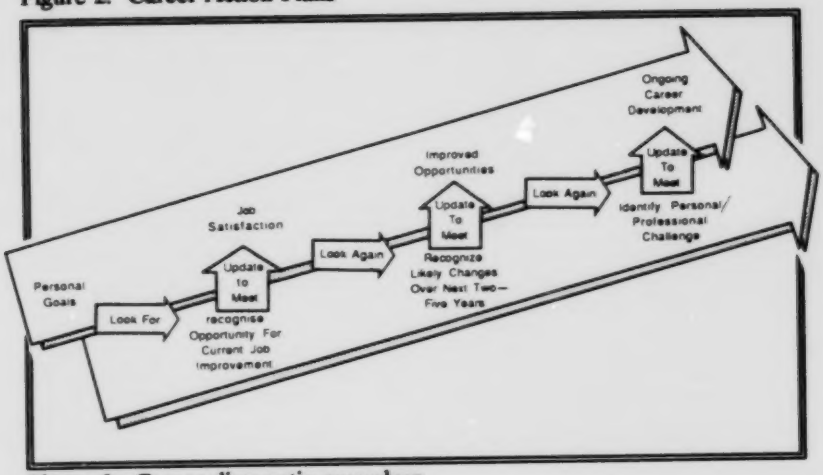
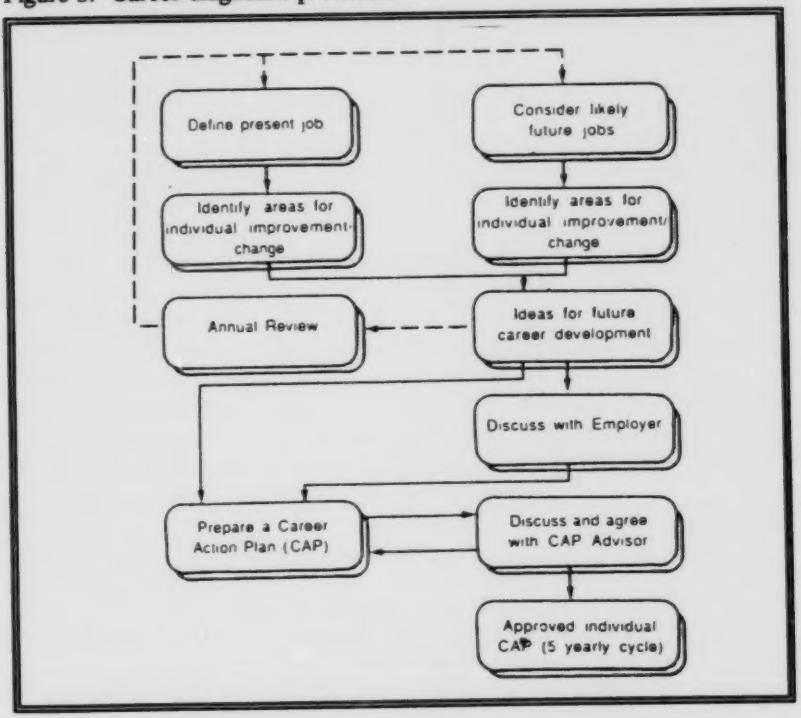


Figure 3. Career diagnostic procedure


Define present job
Consider likely future jobs
Identify areas for individual improvement/ change
Identify areas for individual improvement/ change
Annual Review
Ideas for future career development
Discuss with Employer
Prepare a Career Action Plan (CAP)
Discuss and agree with CAP Advisor
Approved individual CAP (5 yearly cycle)

Categories of Knowledge and Skills
- Technical
- Managerial
- Personal

Learning Methods
- Qualification courses
- Industry- or discipline-related external courses, seminars and conferences
- Private study, correspondence courses, open learning
- In-company courses
- Planned experience
- General work experience
- Mentor guidance
- Committee work
- Writing, speaking, tutoring

Universities and Schools of Mines

The earliest universities are thought to be those of Bologna and Paris which were founded in the first half of the 12th century, with Oxford and Cambridge being established in the United Kingdom a little later. In these early days, only certain fields of study such as the Classics, Theology and Law were considered suitable for study at universities. Consequently, other institutions had to be developed to teach science and technology. They were referred to as Schools, hence the origin of Medical Schools and Schools of Mines.

The oldest School of Mines still operating is the Bergakademie in Frieberg, Saxony, which was established in 1765.

A whole spate of such Schools were established in Australia in the 19th and 20th century and of these, the Western Australian School of Mines is the only one still operating in the traditional mode. Some of the others have ceased to function whilst others have expanded and become a relatively small part of a much larger institution.

Universities by and large do not have a good track record of responding quickly to the community's changing needs, and unfortunately many universities have become too insular, protective and elitist.

It was as a consequence of the universities' inability to meet the demands of the changing technological scene that the *"Institutes of Technology"* and more recently the *"Polytechnics"* were established in the U.K. In Australia, the binary system was established for the same reason, with the *"Colleges of Advanced Education"* having been created in the early seventies to provide a new breed of vocational courses for professionals and para-professionals.

These institutions also proved to be more reactive to the needs of individual students and consequently they enroled more external, part-time and mature students.

In the recent past, the higher education system in Australia has been shaken to its roots by the establishment of the *"Unified National System"*. Many of the older and more traditional universities are having to amalgamate with other institutions to create larger multi-campus universities whilst other institutions are being upgraded to university status.

All Australian universities in the *Unified National System* have to submit their educational profile to the Federal Department of Employment, Education & Training for scrutiny, and it is on the basis of their approved profile that the institutions will be funded.

Another important fact is that, as a nation, Australians are living beyond our means and we all have to tighten our belts. Government funding for the university sector is diminishing in real terms, and we are all having to generate closer ties with the communities we serve and develop private sources of finance.

As you can imagine, there is a strong wind of change blowing through the corridors and classrooms of our universities. There is going to be less emphasis on tenured appointments, and the universities now have the flexibility to offer attractive contractual positions to high-profile applicants. That apart, they have the freedom to offer financial inducements to those staff they wish to keep.

Our universities are also having to increase their income from non-government sources, and encouragement is being given to those with entrepreneurial flair who have the capacity and the vision to initiate commercial ventures and income-generating activities.

Commercial Services at the Western Australian School of Mines

Over the past three years, the School has developed its own range of commercial services. Some two years ago, we established a private $2 company as a wholly owned subsidiary of the university. This company allows us to employ people without the complication of having to fit them into the university's award system. Our Manager Commercial Services was appointed in this way.

The School currently has the following income-generating activities in its range of commercial services:

- Brodie-Hall Mining Research & Consultancy Centre
- Hainault Tourist Mine
- Agricola College (the School's residential college)
- WMC Conference Centre

Within the past 12 months, $200,000 has been obtained from ten mining companies as donations or pre-payments for contract research or consultancy services in order to assist us in establishing The Brodie-Hall Research & Consultancy Centre Pty Ltd. This seed money is being used to employ Senior Research Fellows who devote 80 percent of their time to academic tasks such as routine teaching and supervision of research students.

The School has recently accepted responsibility for managing the local tourist mine because of its profitability and our ambition to operate a tourist and training mine on a new site. In the meantime, those of us involved with this venture are gaining valuable experience in attempting to solve a range of mining technology problems whilst generating an extremely valuable income for the School.

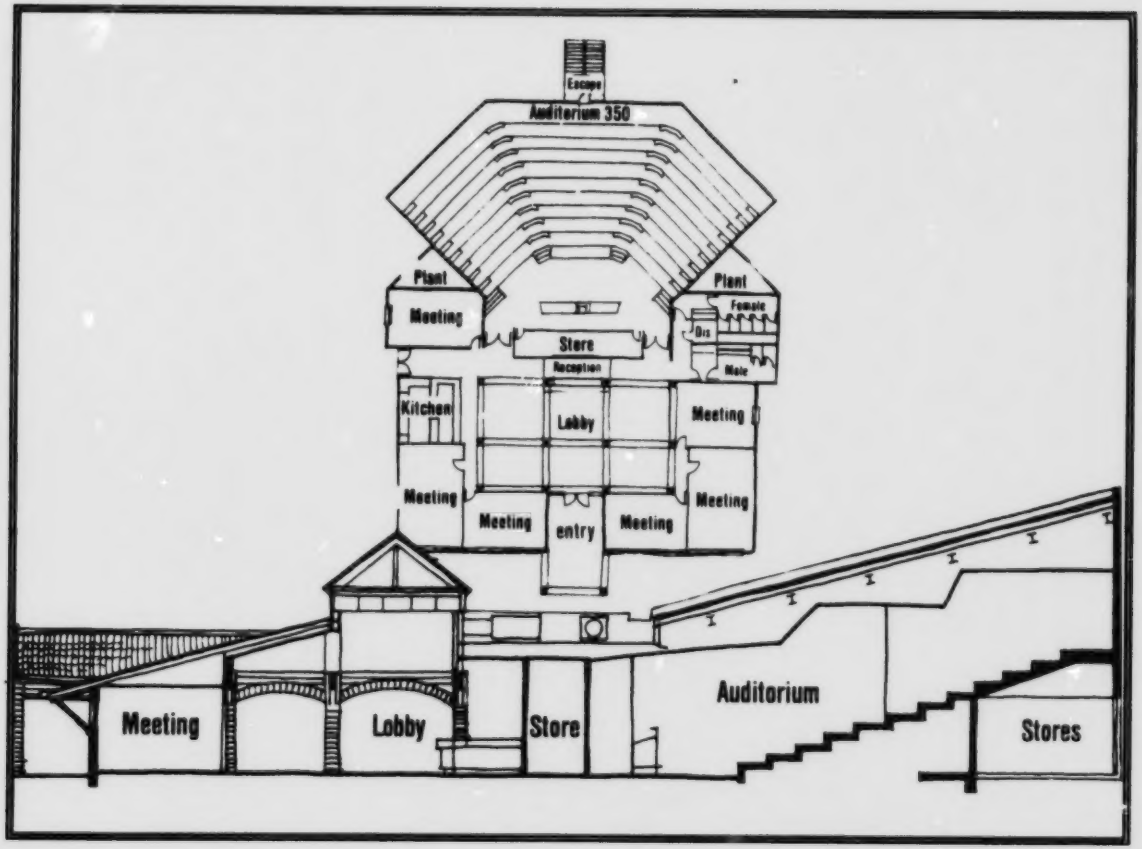
Agricola College, the School's residential college, has the capacity to house 139 students and must be run along commercial lines. All of its premises are air-conditioned and can be used in conjunction with the conference centre during the non-teaching periods in July and during the Christmas break (November-March).

Following a submission from the School to the Board of Western Mining Corporation (WMC), A$1.5 million dollars was allocated for the construction of a conference centre on the School's campus in 1988. This building was officially opened on 10 August, 1989 and is becoming the focal point for the School's Continuing Education Program. The centre contains a 324-seat auditorium with all modern audio-visual aids, six seminar/workshop rooms and a large foyer area as shown in Figure 4.

Continuing Education at WASM

Mining Schools should have extremely close ties with industry, if only for the reason that the quality of the education they offer depends in large measure on the strength and quality of these ties. In this regard, WASM is fortunate in its location at Kalgoorlie-Boulder, the centre of a highly productive and prospective mineral province.

Figure 4. WMC Conference Centre



Having established close ties with most of the mining companies operating in this State, the School has benefited greatly from the recent boom in the gold mining industry and temporary upswings in the fortune of other mineral producers. Indeed, over the past five years the School has obtained about A$5 million from industry sources for the following projects:

• expansion of Agricola College	$ 900,000
• purchase of a rock-testing machine	$ 350,000
• construction of WMC Conference Centre	$1,500,000
• operation of an industry-sponsored scholarship scheme	$1,500,000
• establishment of a research & consultancy centre	$ 200,000
• establishment of a sponsored chair in Mineral Economics & Mine Management	$ 500,000

It is also important that mining schools be reactive to the needs of industry, and one of their main tasks is the production of good-quality graduates and postgraduates. Consequently, it is important to ensure that good-quality students in sufficient number flow into mining schools from our senior high schools. To do this we must use every trick in the book, inclusive of television advertising and ensuring the availability of prestigious scholarships.

Conversion courses should also exist to allow those who have completed a non-mining related engineering or applied science course to specialize in an appropriate mining-related field of study. WASM has such courses in mineral exploration & mining geology, mining engineering and extractive metallurgy.

Good-quality and relevant research work should also be pursued at our mining schools, and the best evidence of its quality and relevance is the willingness of industry to sponsor research projects.

Finally, mining schools need to be in tune with the short-term needs of the mining industry for up-dating the knowledge and skills and/or retraining some of their technical and professional staff. Consequently, it is imperative that mining schools become actively involved in the field of continuing education. Apart from its educational merit, it also generates a private source of income since all short courses have to be run along commercial lines.

Following is a list of short courses available at the WASM in 1990:

Course Title	Duration of Course
Plastics Welding for the Mining Industry	2 days
Mineral Industry Induction Course	2 days
Computer Aided Design of Open Cut Mines	3 days
Atomic Absorption Spectrometry	2 days
Advanced Mineral Processing	2 days
Sampling & Ore Reserve Estimation	2 days
Mineral Economics - Theory & Practice	3 days
Noise Control in the Mining Industry	2 days
Accident Investigation & Analysis	2 days
Basic Chemistry, Physics & Human Biology	2 days
Mineral Processing for the Gold Industry	2 days
Exploration Geophysics for Geologists	2 days
Process Control in Mineral Processing Plants	2 days
Bullion Analysis	2 days
Column Flotation	2 days
Computer Aided Design of Underground Mines	3 days

In addition to these courses, which will be available at the WMC Conference Centre on campus, the School is also reacting to the needs of the expanding mining industry in South East Asia. Consequently, the following three courses will be made available at Jakarta, Indonesia, in the second half of 1990.

Course Title	Duration of Course
Sampling Evaluation and Basic Principles of Ore Reserve Estimation	2 days
Advanced Methods of Ore Reserve Estimation	2 days
Epithermal Precious Metal Deposits	3 days

Another important element in the continuing education programme being developed at WASM is the proposal to develop a range of postgraduate courses in the field of "mineral economics and mine management". Gold production in this State has for many years been tax- and royalty-free, a great incentive for exploration and mine development. Another great boon to gold mining companies has been the introduction of gold loans as a means of financing mine development. This involves the bullion dealer lending gold to the producer who sells the gold on the spot market for cash. This loan is given on the strength of the gold that the mine developer has proven to be available within the orebody which is defined in the feasibility study report.

One of the most attractive features of gold loans is the low borrowing cost of between three and five percent and a drawdown period of between two and five years is normal.

That apart, most gold producers forward-sell a proportion of their gold production as a form of insurance or protection against the possibility of a severe downturn in the world price of the metal.

The world-wide trend towards financial deregulation reached Australia in the early 1980s, and this has also had an impact on the way in which our mining industry has developed in recent times.

Indeed, few countries have deregulated their economy as rapidly and thoroughly as Australia has done. The elimination of the "30 day rule" has increased competitiveness in the merchant banking sector and there are currently over 100 merchant banks operating in Australia. Deregulation has also resulted in increasing internationalization of the Australian financial and securities markets, which give rise to an escalation of take-over activity.

In recent times it is also interesting to note that corporate treasurers and financial institutions have shown no reluctance in becoming involved in interest rate and currency swaps in the management of both sides of their balance sheets.

Apart from these developments which have had, and are likely to have, even more impact on the future development of our mining industry, the management of the industry's human and material resources needs more attention. Whilst past graduates and postgraduates from our mining and engineering schools have been technically and technologically sound, they certainly have a weakness in the areas of financial, human and material resources management. Consequently, we are strengthening these areas of study in our undergraduate courses at WASM and plans are well advanced to produce a new course-based Master's degree in Minerals Resource Management for professional staff employed in the industry.

Over the 30-month period of this postgraduate course, a total of eight sessions of three to four weeks' duration of intensive study will be organized in Perth or Kalgoorlie.

The course objective is to offer education and training to engineers, accountants, lawyers, economists and others associated with the mining industry in the fields of Mineral Economics & Mine Management. The course will have three distinct phases leading to the following awards:

Phase 1	96 credit points	Graduate Certificate
Phase 2	96 credit points	Graduate Diploma
Phase 3	192 credit points	Master of Applied Science

A gold mining company (Metana Minerals NL) and a private donor have recently underwritten the cost of establishing a Chair in Mineral Economics

& Mine Management at the School and it is hoped a suitable applicant will be found in the near future. Nine seminars have been held at centres throughout this State in order to elicit the views of professional staff regarding these proposals. The reaction from all quarters was positive and the developments thus far have been strongly supported by the Institution of Chartered Accountants.

It is essential that such courses meet the needs of industry and we have therefore decided to market these postgraduate courses as full-fee programmes. Apart from ensuring the continued relevance of the courses, tuition fees of about $30,000 per person will enable us to meet the cost of running such a high-profile and expensive programme.

Conclusions

Despite what the so-called *"Greenies"* say, the mining industry is essential to our civilization and we need to be much more vocal in reminding our fellow citizens of this fact. Mining can be pursued in an environmentally acceptable way and is, in point of fact, being done so in most instances nowadays.

Mining Schools play an important and fundamental role in ensuring the well-being of the mining industry. After all, it is the Mining Schools supported by mining companies which recruit and educate young people for the mining industry and we must ensure that an adequate number of good-quality applicants enter our Mining Schools.

Mining Schools must also maintain close and effective links with the mining industry and there are various means by which this can be achieved. One means of so doing, which is of increasing importance, is the provision of continuing education programmes for technical and professional staff employed in the mining industry. Rest assured, if Mining Schools can be successful providers of this service, it will help their full-time staff keep their teaching programmes both up-to-date and relevant.

The success of WASM over recent years has depended on the input of many individuals, many of whom are captains of industry. Some of them are members of the School's Board of Management which is so ably chaired by Sir Laurence Brodie-Hall. His close association, friendship and support have certainly been of inestimable value to me, and his ability to raise funds for our many activities has been second to none.

Responsibility for Training and Education

Hugh C. Morris

A key point in this panel discussion is the relationship between the education process and the basket of knowledge which our business and industry requires; that is, the cultural impact and what we are doing and what we can do about it. These are not quite clear.

One can first analyze the nature of our industry: how it's organized and what the nature of the required knowledge is. We can look at whose job the educational task is. For working definitions, I would separate and place in the education basket the basic fundamental principles of knowledge that one needs and, in an enlarged training basket, all the things that are much more specifically industry-related or location-related. I realize we can have endless debates about this distinction, but I'd like to use this as a basis for my remarks. We're really trying to identify the intellectual and knowledge requirements in the basket of skills in our business. Our industry is technology-driven, very cyclical. We've tended in the last couple of days, except for the industry representatives, to dodge the financial and economic impacts of all this. I don't think that's quite realistic and it does leave out some strange points.

Trained as a geologist, Dr. Morris has been involved in various aspects of mineral exploration and development for 36 years. He has worked on a worldwide basis for several companies. For 18 years he was employed by Cominco Ltd. in its Exploration and Mining Departments in several Canadian locations, more latterly as Director – Explorations for its worldwide activities. In 1979, Dr. Morris became associated with the E & B – Geomex group of affiliated companies, initially as President and Chief Operating Officer of Minerals, Inc., and in 1981 as President and Chief Executive Officer of E & B Canada Resources Ltd., Calgary. In 1983, after the merger of E & B and Imperial Metals Corporation of Vancouver, he became Chairman and Chief Executive Officer of Imperial Metals. He is an active member of several professional and scientific societies, including the Geological Association of Canada, the Geological Society of America, the Geological Foundation of Canada, the Canadian Institute of Mining and Metallurgy, and the U.K. Institute of Mining and Metallurgy.

There is one thing we should realize: our human resources are very transient and sometimes migratory, and the industry as a whole has been very self-sufficient in the past. All these observations about our bad relationships and so on are to some extent the results of having been a reasonably successful, self-contained industry. It's worked. It's not hard to understand why a CEO in a large company would ask, "Do I need all this analysis and new methods? It's working, isn't it"? It's the old syndrome, "If it ain't broke, don't fix it." At the moment, it seems to be limping, which is why everyone is worrying about fixing it.

Our attitudes towards human resources have changed tremendously and so has the nature of knowledge. We talk about the basket of knowledge doubling every seven years. The clear implication is that over a career span, you're probably looking at a tenfold increase in the available basket of knowledge. This tells you right away that somebody coming in is going to be obsolescent pretty fast. He may be useless long before he reaches the end of his career unless somebody does something about it. If you're an employer, you can basically amortize his skill, depreciate it and liquidate the asset if you want to. Such economic analyses are very valid in our industry, and yet in our discussions here, no one has addressed our future needs. Do we really want 2000 graduates, 3000 people in the programs every year? That has not been considered.

We're all aware our knowledge has been focused in the education part, principally at the university, principally at the bachelor's programs. They are systematic; after that, it becomes much more random. You get into advanced education in much the same ways as you get into advanced skills: by a mixture of luck, of being in the right place at the right time, a piece of self-motivation and a bunch of coincidences. That doesn't strike me as being part of good management.

Another thing that turns up has always been the sense of investment in the education process. You can understand a major corporation scratching its head about continuing education and continuing training. From the perspective I have, which is with a much smaller company, we have to ask very hard whether we can afford it. I don't think we can; we're much better off to let Falconbridge and Noranda make the investment in the human asset and when we want it, we'll buy it. It makes far more business sense to us than it would to the bigger companies, but in our industry, no company is dominant. Northern Telecom account for 80 percent of their type of business in Canada. Their systems, their control, their management of the resource are easy and a good investment because they can't lose it – they can't be robbed. In our industry, even the Incos and the Norandas can be robbed by people like ourselves.

On the following page is a matrix which shows five of the stakeholders, or citizens, in our industry and five requirements. Each cell assesses who has the ability to perform a task and who should really be regarded as generally accountable for its performance. The scale is from 0 to 4, with a score of 0 indicating no ability or accountability, 1 indicating little ability or accountability, 2 significant but minor ability or accountability, 3 significant ability or accountability, and 4 representing the group with the most ability or accountability.

The five citizens are the *individual*, of course, the *industry* as a whole, another grouping which is *sub-industry* in size, but which has to sit somewhere in between the individual and the whole industry (by profession here, I'm including any grouping, so this includes unions, professional associations of various types, skill-related or education-related ad-hoc groupings), the *educator* (and this is the institutionalized educator, the university) and, finally, the individual *employer* as a discrete business organism within our capitalist structure.

The items which I would argue are the subdivisions on the requirements side of the matrix are *background*, which means the level of knowledge – because this is all knowledge-driven – in societies. This relates, obviously, to what we have heard about high schools, public information and so on. *Education*, by definition at least, is the formal, high-principle education in the things which are deemed to be necessary, the fundamentals like mathematics, physics, chemistry, biology. This must be separated from *training*, although is obviously a gray boundary – where does education stop and training begin? (As an aside, I'd like to provoke the business schools by suggesting that in many cases they're more on the training side of the line than the education side, and that's supported by statements that they themselves make. When they say, "We'd like to get heavily into the case business," they're really saying, "We're back in the real world, we're back in the business environment.") But from here on, we go back to that notion of the seven-year or ten-year doubling of knowledge and I would suggest, at least for this argument, that both *retraining* and *continuing education* should logically have to occur at the rate of expansion of the world's and or industry's knowledge.

In summary, I would say that continuing education is an issue of collective responsibility with individual motivation. We have few systematic education or retraining programs, and we must both develop a culture where these are a condition of employment and design some initiatives to provide them.

Ability / Accountability	Employer	Educator	Professional	Industry	Individual
Background	1 / 1	3 / 3	2 / 3	2 / 3	1 / 0
Education	0 / 0	4 / 3	0 / 2	0 / 2	0 / 3
Training	4 / 2	0 / 1	0 / 2	1 / 3	1 / 1
Retraining	4 / 1	0 / 0	0 / 2	1 / 3	1 / 1
Continuing Education	0 / 1	3 / 3	3 / 3	1 / 3	0 / 3

Experiences with Continuing Professional Education for the Mineral Sector

Brian W. Mackenzie

Introduction

During the past twenty years, Canada's preeminent position as a supplier of mineral commodities for world markets has come under increasing competition. As we move into the 1990s, there is a common need to realize more fully the economic potential of the Canadian mineral sector.

In order to succeed, we must insure that the human resources invested in mineral exploration, mine development, and the production of mineral commodities are of the highest quality. Thus, mining companies and government departments with mineral sector responsibilities must give top priority to developing their human resources. The cost of doing so should be an integral part of their capital budgets and strategic plans.

Dr. Mackenzie is a senior research associate of the Centre for Resource Studies and a professor in the Department of Geological Sciences at Queen's University. He received his formal education in mining engineering and mineral economics at McGill University, the University of Witwatersrand, and Columbia University. In his early years, he worked for Sheep Creek Mines, Union Corporation, the South African Department of Mines, and Energy, Mines and Resources Canada. From 1968 to 1977 he was responsible for teaching and research in mineral economics at McGill University. He was also director of McGill's mining program from 1974 until he joined Queen's University in 1978. Dr. Mackenzie has carried out a wide range of assignments on mineral policy and planning issues for mining companies, governments, and international agencies. In 1977 he was named distinguished lecturer in mineral economics by the Canadian Institute of Mining and Metallurgy, and in 1983 he received the Institute's "Robert Elver Mineral Economics Award". He has presented mineral economics seminars in Canada, Australia, Brazil, Chile, China, Finland, Greece, Indonesia, South Africa, Sweden, Tanzania, and the United States.

Terms of Reference

One aspect of human resource development is the on-going education of professional staff which begins when they graduate. In the mineral sector, there is a demand for educational opportunities for geologists, mining engineers, metallurgists, and other professionals as they advance from junior technical and supervisory positions to increasing levels of managerial responsibility.

This note reviews my own particular experiences in addressing this demand over the past 25 years. During this period, I have invested six to eight hours per day of my time, five to six days per week, for more than 100 weeks presenting mineral economics seminars to professionals in the mineral sector. These seminars, varying from three days to three weeks in duration, have responded to a variety of needs in Canada, Australia, and ten other countries. In addition to this front-line involvement, for several years in the 1970s I was responsible for managing a continuing education program for the mineral sector at McGill University.

I will briefly outline these adventures in education with a view to highlighting the main lessons learned from them which might be useful to consider in planning ahead. Three of these experiences, representing distinctive professional development models, have had the greatest influence on my thoughts on the subject.

Experience 1: McGill University

My ideas concerning continuing education were shaped initially by a remarkable individual, Professor Frank White, an Australian mining engineer, who came to McGill University in the mid-1960s as Chairman of the Department of Mining Engineering. At McGill, he implemented a course-work master's degree program in mining which was designed mainly to stream graduates in other engineering disciplines into the mineral sector. A unique feature of this program was a series of intensive two-week short courses, varying in number from six to eight each academic year, on aspects of mining technology, management, and economics. These short courses were presented

- to graduate students in the applied master's program who took them for academic credit; and
- to industry and government participants who registered for specific courses as a form of continuing education.

I began my ten years on staff at McGill in 1968 as part of Frank White's group. My role was to develop teaching and research activities in mineral economics. One aspect was to present the two-week course in mineral economics. This was done with the support of the Canadian mining industry. Don Worth, Wil Barbour, and Ted Yeates were particularly helpful.

The two-week mineral economics course, like McGill's other offerings, had modest beginnings. Nevertheless, we were able to develop an impressive continuing education program from that base. Since then, the McGill seminars have been presented to over 3,000 participants, mainly from Canada but also from 40 other countries.

The McGill experience illustrates the role of the university in continuing education and the benefits which can be realized by satisfying short-term and longer-term needs for professional development together.

Experience 2: Australian Mineral Foundation

The Australian Mineral Foundation (AMF) is a non-profit organization established in 1970 by the mining and petroleum industries in Australia. The dual responsibilities of the AMF are continuing professional education and information services.

The AMF is financed mainly by subscriptions from member companies, course fees, and revenue from business activities. It is administered by a council representing companies, government agencies, universities and professional institutes associated with the Australian mining and petroleum industries. The organizational structure includes a Director and about 15 full-time management and support staff. Facilities, located in Adelaide, include an auditorium, seminar rooms, computer laboratory, library, bookshop, catering service, and staff offices.

With respect to information services, the AMF has established the Australian reference data base on published and unpublished mining and petroleum-related literature. This data base currently contains 70,000 cross-indexed references, including open-file company exploration reports and unpublished government reports. A quarterly compilation of the latest literature alerts the professional to what has been written, and the AMF facilities back this up with the provision of requested items.

The continuing education courses, normally one to two weeks long, cover a wide range of subject areas from mineral and petroleum exploration, project assessment, mining, mineral processing, extractive metallurgy, petroleum engineering and production, to related areas such as management, economics, law, and the environment.

I have been associated with the AMF since 1975, presenting 18 workshop courses in mineral economics. Attendance at these courses is restricted to 30 participants to encourage a stimulating, interactive learning environment. Emphasis is placed on small-group work to build up a hands-on understanding of quantitative methods and applications. Participants are invited to bring practical problems with them for discussion and analysis. Microcomputer demonstrations and workshops relating to mining project evaluation and optimization have been a feature of these courses in recent years.

To date, the AMF has offered some 600 courses with attendance exceeding 11,000 participants. Course leaders are selected from Australia and overseas. While the main venue is the AMF facilities in Adelaide, courses are held also in other Australian capital cities and industry centres when convenient. Courses typically utilize a blend of teaching methods involving lectures, discussions, workshops, case studies, demonstrations, and field visits as appropriate.

The AMF is a unique industry-funded organization responding to practical needs for continuing professional education in the Australian mineral and petroleum sectors. This experience also illustrates the synergy which exists between continuing education and information services in formulating new ideas and applications, and the transfer of these to those involved with operational problems and projects.

Experience 3: Western Mining Corporation

Western Mining Corporation (WMC), established in 1933, is one of Australia's largest business enterprises, employing about 7,200 people. Operating revenues in 1989/90 were over $1.7 billion. WMC is a major world nickel producer and Australia's largest gold producer, with substantial direct copper, uranium and talc interests as well as a major indirect interest in alumina and aluminum production. The company is also active in petroleum exploration and production, and has overseas mineral interests in Fiji, Brazil, and North America.

WMC was probably the first company in the world to adopt a deliberate policy of trying to use geological science as an aid to successful mineral exploration.[1] Exploration is central to the growth of the company. In 1989/90, approximately $101 million was invested in exploration, representing over 7 percent of sales and 24 percent of after-tax profit.

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[1] Roy Woodall, "Success in Mineral Exploration", *Geoscience Canada*, vol. 11, 1984.

Most of what WMC has to mine was found by its exploration people. The heart of the company's present Exploration Division is its 170 geologists, geochemists, and geophysicists who work both on mines and in regional exploration where scientific research of the highest standard is encouraged.[2]

My association with the Exploration Division of WMC began in 1973. The initial assignment was to assemble an exploration expenditure and mineral deposit data base to assess the economic potential of mineral exploration in selected Australian environments. While this type of empirical research has been updated and extended on a continuing basis since that time, the terms of reference for my involvement soon began to subtly broaden into more generally helping provide an economic overlay for their activities.

The association has always been close and interactive. A senior WMC geologist has been seconded to each study to work with me and provide liaison. Periodic meetings with Roy Woodall, Director of Exploration, regional exploration managers and senior geoscience specialists are held to review work in progress and discuss how to derive maximum benefit from the data base and study results.

The presentation of one-week in-house seminars on economic guidelines for exploration has been a part of this educational process since 1975. About twenty geoscientists from WMC exploration programs and mines typically participate in each of these sessions. While the content is similar to the seminars I have been involved with at McGill and the AMF, a more specific focus on company exploration interests is possible. Several WMC case studies are prepared in advance for participants to work on in teams, present and discuss during the seminar. This brings the relevance of the analysis techniques and applications closer to home than is otherwise possible.

These Exploration Division seminars have created an awareness throughout the organization of the economic dimensions of exploration which complements the scientific-technical basis for success. Reinforcement over a 15-year period certainly has helped develop the confidence necessary to use the techniques involved in various ways from the initial formulation of strategies and plans to the evaluation of on-going exploration programs and projects.

The WMC experience illustrates the contribution which in-house seminars can make as one component of human resource development. It also demonstrates that continuing education is a two-way street. The opportunity to work with the Exploration Division of WMC has been a vital part of my own professional development.

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[2] *Ibid.*

Other Experiences

The continuing education programs I have been involved with at Rhodes University in South Africa and here at Queen's University are similar to the McGill experience although more limited in scope. In these cases, mineral economics short courses are presented both to full-time master's students for academic credit and to external industry and government participants. A notable feature of the Queen's seminars is that they benefit from the use of the Donald Gordon Centre, a totally integrated complex designed for continuing education which includes seminar, workshop, accommodation, meal, recreational, and administrative facilities.

In other university cases, professional development seminars tend to be run independently of academic programs. My experience along these lines has included short course presentations at the State Technical University in Chile, Beijing University of Iron and Steel Technology, Helsinki University of Technology, the Federal University of Bahia, and Memorial University of Newfoundland. While this type of seminar helps satisfy the demand for short-term educational opportunities in the mineral sector, the benefits of involving full-time graduate students are foregone.

Other non-profit institutes and government agencies also are active in organizing continuing education programs on behalf of the mineral sector, *ad hoc* versions of the AMF role in Australia. With this type of organizational setting, I have been involved in mineral economics seminars as part of the vacation school program of the South African Institute of Mining and Metallurgy, for the State Mining Corporation in Tanzania, the Mineral Technology Development Centre in Indonesia, the State Mining Property Commission in Sweden, and the Departmento Nacional da Producao Mineral (DNPM) and the Associancao Brasileira do Mineradores de Ouro (ABRAMO) in Brazil. The Brazilian short courses have been held in CENTRECON, another self-contained facility for professional education, located in a peaceful study environment of natural beauty 100 km from Rio de Janeiro. While these initiatives satisfy particular practical educational needs in the mineral sector, they generally lack the continuity, scope, and infrastructure required for a more comprehensive and longer-term commitment to professional development.

Beyond the WMC experience, I have presented in-house seminars for the following: Iron Ore Company of Canada, Inco, Shell South Africa, Saskatchewan Mining Development Corporation, Texasgulf, BHP, Gold Fields, Codelco-Chile, and the Institute of Geology and Mineral Exploration (IGME) in Greece. Most of these assignments have benefited from the advanced preparation of case studies on current company planning issues and mining projects for analysis and discussion during the proceedings.

Main Lessons Learned

What have I learned from these experiences which may be of interest in planning present programs?

- Information services, applied research, and continuing education are interrelated functions. The role of the education function is to transfer new information and research ideas into improved practice. Those involved in providing this type of education should have strong connections with the related information and research activities.

- Within an organization, the education of professional staff should encompass a wide spectrum of opportunities ranging from on-the-job testing of new concepts and technology, in-house discussion, short courses and seminars, to a program for graduate study leave.

- In the mineral sector, the needs of organizations for short courses and seminars to a large extent are similar. Therefore, this shorter-term demand for continuing education can be satisfied most efficiently on a sector-wide basis.

- In-house seminars provide an opportunity to focus on particular organizational issues in a way which is not otherwise possible. On the other hand, sector-wide seminars bring participants from a variety of organizations together to share experiences and discuss common interests. The improved communications which have resulted from professional contacts and associations initially formed at this type of seminar among companies and between industry and government are commonly cited retrospectively as one of their main benefits.

- The presentation of a professional development program is not just making up a brochure, sending it out, putting notes and transparencies together, and waiting for participants to fall out of the sky. Persistent up-front effort and organizational infrastructure, which are both time-consuming and costly, are required for successful implementation. The most critical ingredients are first of all, the identification and quantification of market needs and, then, the matching of priority needs with seminar leaders who can do the job. An on-going administrative facility then takes over to handle publicity, registration, finances, and operational aspects of the process.

- Continuing education should be conducted away from the workplace and the home environment of all concerned to encourage total immersion and concentration on the short learning experience. It is difficult enough to teach and learn without being distracted by other responsibilities.

- An inter-active seminar format is essential when working with experienced professional participants. Discussions, workshops, and small group presentations build up confidence in problem-solving skills and help keep the proceedings practically oriented. The more participants are prepared and allowed to put into seminars, the more benefit they derive from the experience. To foster this type of environment, enrolment in short courses normally should be limited to a maximum of 20 to 25 participants, perhaps extending to a limit of 35 to 40 where seminar facilities are ideal.

- An integrated self-contained facility including seminar room, small-group rooms, dining, accommodation, and recreational facilities is by far the best type of arrangement for continuing professional education. A stimulating group dynamic flourishes in this atmosphere. Instead of abruptly adjourning at 5 p.m. each evening, the educational process can continue less formally at dinner, during evening workshops, and later over a beer or two in the pub. The motivation and familiarity built up in this way over several days substantially enhance the learning experience.

- In terms of information services, research involvement, teaching resources, and educational facilities, universities are best equipped to provide continuing professional education for the Canadian mining sector. With a few notable exceptions, this potential has not yet been realized. There is a pressing need from both academic and industry viewpoints to do so now before theory and practice which need each other become more alienated.

- At Canadian universities we have a tremendous opportunity, largely unfulfilled as yet, to combine short-term and longer-term aspects of continuing professional education. In other words, professional development seminars are offered both for academic credit in full-time graduate study programs as well as to satisfy more immediate mineral sector needs. The benefits associated with this format include

    - efficiency of meeting two types of continuing education demand in a single program of short courses;

- external participants enjoy the opportunity of mixing with and learning from graduate students who already have been exposed to the subject;
- graduate students obtain a more applied perspective on the topic from the external participants and an improved understanding by playing a leadership role in small-group workshops;
- more practical orientation of academic staff resulting from the requirement that they successfully design and lead seminars which respond to real-world demands for professional education;
- profit earned on seminar fees can provide an important source of discretionary funding for a university department which helps obviate normal provincial government and university financial constraints.

Conclusion

There are enough practically oriented academics in the Canadian university system with teaching and research expertise in the geosciences, mining, mineral processing, and management to satisfy present and future needs for continuing professional education in the mining sector. What is lacking are the vision, financial resources, infrastructure, networking, and persistence required to develop a comprehensive country-wide and sector-wide program. There is a common interest in realizing this opportunity. Who will take the initiative?

Human Resource Management

Dennis Shannon

What do we need for a well-qualified, professional and technically skilled worker?

A qualified worker knows how to solve the problem at hand and how to work with other people to see a solution implemented. The challenge is to remain capable of using the tools and techniques which are developing at such a rapid pace. Clearly, learning and education now, more than ever before, constitute a life-long task.

It seems that education in a formal setting at a university or college is seen as an isolated experience. We go to school, jump through the hoops, learn some basic skills, then enter the real world of industry. Often, the feeling is that once in industry we will learn how things are really done.

Industry is, indeed, a separate world of activity. The bottom line is that the mine must operate efficiently and productively. In recent years, most companies have put greater emphasis on training and development of skilled workers. This training, however, to a large extent, has been an in-house affair.

Government is also a factor in the mining industry. The activity of government agencies and related groups exist largely in a sphere of activity somewhat removed from education and industry. Government is often seen not so much as a partner, but rather as a separate entity requiring a particular response.

The three groups, educators, industry and government, need to work together in an integrated system to gain maximum human resource planning.

Mr. Shannon has had an interesting and varied career in many aspects of the mining industry. Presently Executive Co-ordinator of the Ontario Centre for Ground Control Training (Cambrian College) in Sudbury, which involves teaching, program development, and production of training videos, he also runs a consulting business specializing in blasting. Mr. Shannon is a graduate of Cambrian College, both as a civil engineering technologist and mining engineering technologist, and holds a Bachelor of Science (Mining and Sociology) from the University of Alaska. He has extensive experience in conventional and mechanized underground mine development with several companies in Ontario, Quebec and Australia.

It seems to me then, that the educators have a pivotal role to play in the system. Both industry and government groups have major responsibilities beyond education. The educators alone have the mandate to teach and facilitate an integrated system.

Ground control is an area I have been closely involved with for the past few years at Cambrian College. When a ground control problem develops at a mine, people must examine the problem and deal with the situation. The groups usually involved in the problem consist of government, a production person from the mines and an engineer or technical specialist.

Over and over again, it becomes apparent that, to solve and reduce the problems, effective communications among these three representative groups are essential. Very often it is not until a major event triggers close interaction that the three groups really communicate or interact.

The groundwork, then, for an integrated industry should flow through our educational system. This seminar is being held at a unique time and Queen's University is to be commended for this initiative.

Interaction does exist in all areas, but it is due more to individual directives rather than structural approach. Ontario universities have three chairs in rock mechanics. One is here at Queen's University, another at the University of Toronto, and one at Laurentian University. As well, there is the Ontario Centre for Ground Control Training at Cambrian College. All of these institutions have some interaction which has a positive effect. In order to fully utilize the resources available, we have to ensure ongoing development and growth.

I believe we need a more formal organization and integration of our groups and resources. Education is indeed a life-long activity if we wish to remain effective in our duties. In the day-to-day operation of a mining property, effective communication and interaction are essential. To promote interaction and understanding between groups, our education should reflect these values.

Some suggestions for interaction and cooperation are as follows:

- Use distance-education systems, as well as video, interactive video and satellite transmission.
- Mining is a trade. It should have a recognized curriculum of theory, as well as the practical.
- Where course material permits, have engineers, technologists and miners take short courses or seminars as an integrated group.
- Have industry representatives present information or, where possible, teach some part of a course.

- Have mining teaching staff involved with industry, on a regular, scheduled basis.
- Have regular scheduled field trips to mines, as well as summer jobs for mining students.

One suggestion: A recognized group consisting of members from industry, government and education could meet each year to set an agenda of formal activity for the year.

Issues in Education

Klaus V. Konigsmann

A recently held workshop on plant and process automation in the mining industry examined the causes for the relatively slow and spotty application of this technology. Our discussion group was unanimous in concluding that the principal impediment was a shortage of people with the appropriate training and knowledge.

When one discusses the topic of advanced mining equipment, computer-operated drills, centrally tracked and diagnosed mucking equipment or underground electrification, sooner or later reference is made again to the shortage of personnel in engineering, particularly in maintenance personnel of all disciplines.

As a matter of fact, it does not matter which part of the mining enterprise one examines with a group of colleagues; the need for better education and training is certain to arise.

Having working in the industry for over thirty years, I have heard similar concerns expressed for a long time. Yet when one looks at our plants and mines today, on the whole, there has been considerable change; for example:

- We have at least one wholly electrified underground operation in Canada.
- Our understanding in rock mechanics is miles ahead of that of yesterday.
- Plant automation is a fact of life.
- Autogenous grinding has become a commonly applied technology, and so on.

It should be conceded that remarkable advances have occurred in spite of perceived shortcomings of our education and training processes. I believe that a lot of our complaints deal with our inability to change fast enough and to apply new technologies quickly enough.

Vice President Engineering of Noranda Minerals, Mr. Konigsmann directs the Toronto Operations Engineering section and is also involved in process and plant design. The development of personnel is one of his particular concerns. Mr. Konigsmann's engineering specialty focused on mineral beneficiation. He has been with the Noranda Group since 1958, after graduating from McGill University in metallurgical engineering.

I presume that at this seminar proposals will have been discussed dealing with academic programs and industrial training. I should like to focus on the rate of change of education depth and the horizon of technical personnel after graduation (or after completed apprenticeship) throughout their careers. I would like to talk about continuing education.

Some proven mechanisms for continuing education exist – conventions, meetings addressing specialized sectors of engineering, extension courses at universities, and the like. These, however, serve only a small segment of the population, and the restricted attendance is determined more by the luck of the draw than through systematic furtherance of individual education.

In this context I will not address such topics as correspondence courses or evening classes, extension courses at university campuses, and in-house training sessions. Each of these approaches covers an established niche and should be encouraged to continue to serve special segments of our employees. However, none appears a suitable approach toward broad-based continuing education.

A system is likely to be widely accepted if it is built on the following premises:

- Courses should be available in or near mining communities, close enough to the place of work, so that travel time is measured in hours and not days.

- Courses generally should be taught during regular working hours, without excluding the possibility of some teaching during weekends, and should be short enough to be compatible with the demands of regular work assignments.

- Courses should be taught by recognized authorities in their field of expertise. At least some courses should earn credits toward an advanced degree.

- Costs should be covered by the employer.

Proposed Course Structure

Location

Courses should be taught in mining communities across the country such as Saskatoon, Thomson, Val d'Or, Estevan, Marathon, etc. Adequate facilities usually can be found at local universities, colleges, schools or hotels.

Session

The fall-to-spring period appears most suitable, say from early October to early May, so that courses do not interfere with holiday schedules. For the initial years of this effort it is suggested that a fairly low number of courses per community per session be scheduled. Three courses may be an adequate first target.

Course Length

The majority should be scheduled for two to three full working days. Preparatory material would be sent to registrants in advance.

Course Content

A suitable mixture will evolve to include technical subjects and topics of human relations and financial matters. Certainly, courses should be available in French and English to suit the majority of participants.

Participants

During the initial years, continuing education should be tailored to the needs of the technical and managerial staffs for the mining and metallurgical facilities in a given area. Hopefully, initial success will lead to a broadening of this service to other groups of employees.

Lectures

The appropriate selection and the quality of courses will guarantee acceptance and success. Only recognized authorities in their fields of expertise should be invited to lecture. The majority will likely be drawn from our universities, but others may also be recruited among suppliers or consultants.

The Mining Industry in Ontario

Hugh P. O'Neil

Since my appointment last August as Minister of Mines, I have visited all the major mining centres in Ontario and have met with many prospectors and developers. I have toured the gold and nickel-copper mines from Red Lake to Ignace, from Timmins to Kirkland Lake, and I have visited gypsum-producing mines in Southern Ontario. In the last eight months, I have seen many mining operations and have spoken to the people who work in them. I feel that I now have a better understanding of the importance of the mining industry in the lives of all Ontarians.

But as you all know, the more one learns, the more questions there are to be answered. For myself, as I travel the province and visit the many international success stories that make up Ontario's mining industry, my central question has become more and more evident: In what manner can my government best interact with industry and the academic world to provide the resources needed to meet the challenges of the next decade and beyond?

It is with this in mind that I welcome the opportunity today to be a part of this important Human Resource Planning exercise.

Without a doubt, the challenges we face in the 1990s seem awesome. The global markets are sailing uncharted waters, brought about by the rapid social changes in the Old World. We have seen the awakening of Eastern Europe, freeing the energies of millions of people who are striving to create in their countries the kind of wealth and social structure we enjoy in the West.

The Honourable Hugh O'Neil has been a member of the Ontario Legislature (Quinte) since 1975 and a Cabinet member since 1985, holding the portfolios of Industry, Trade and Technology and Tourism and Recreation. In 1989 he was named Minister of Northern Development and Mines. He serves on two Cabinet committees: Economic and Environmental Policy, and Northern Development. As a member of the opposition, Mr. O'Neil was Liberal Caucus Critic for the Ministries of Industry and Trade, Culture and Recreation, Labour, Housing and Tourism. He also served on the Select Committee of the Ombudsman, was Vice-Chairman of the Select Committee on Plant Shutdowns and Employee Relocation and a member of the Special Health Committee. Mr. O'Neil is a graduate of Peterborough Teacher's College and worked as a teacher, supervisor and principal in the Ontario school system for six years. He started his own real estate business in 1961 and is a Fellow of the Real Estate Institute.

As they try to imitate the best in the West, our own societies and economies are setting their sights on new horizons, new ways of doing business on the global stage. The conjunction of these two trends promises a 21st century of truly untapped potential – potential which young, energetic and technologically aware innovators can develop.

In many ways, I feel the Ontario mining industry is ready to take advantage of such new opportunities and, at the same time, is prepared to meet the challenges at home. For example, three gold mines and two base metal mines began production in Ontario last year. Inco and Falconbridge have also announced multi-million dollar investments in their Ontario facilities and, this year, a graphite mine is expected to open near Huntsville.

These announcements emphasize the commitment of mining companies in Ontario to spend the money needed to ensure a healthy and profitable future, a future brimming with promise for those willing to grab the brass ring.

Similarly, we have seen a commitment by Inco and other companies to invest in the environment. In this regard, I congratulate the Ontario Mining Association on finalizing its environmental policy and on bringing a heightened awareness of this issue, as reflected in their recently-published *Mining in Ontario – 1990* magazine, which is dedicated to mining and the environment.

I feel this new awareness of environmental issues will lead to a range of new employment opportunities as the industry develops new environmentally sound production methods and hires the technicians and technologists to oversee these new processes.

Over the past few years, Ontario's mining industry has evolved into a lean production machine and has remained competitive in the world marketplace. Staying competitive has meant developing and adopting new technologies. Maintaining that momentum is the challenge you are being asked to take up. It's not only a matter of working harder, but of working smarter.

Here at Queen's University and in other first-class institutions, you are in a position to prepare yourselves for the future. Technological advancement is a fact of life in today's mining industry. But when we think of technological advancement, we should also think in human terms – the quality of the working environment.

Many companies have realized that productivity has increased when their crews were able to work in a better environment. Increased automation in the industry is reducing the number of mining jobs available at all levels. Today's machinery is sophisticated and expensive. And in order to get their money's worth out of this equipment, mining companies are looking for, and insisting on, operators who understand drilling and blasting theories, as well as electrical, hydraulic, and mechanical systems.

There won't necessarily be more jobs in mining in Ontario, but these jobs will be going to the people with the best experience and education available.

The challenge for educators, and for all of us, is to recognize the needs and keep pace with the technological developments.

To this end, the Ministry of Northern Development and Mines is helping the Queen's University Department of Mining Engineering to launch an international congress on mine design. This congress will mark the department's 100th anniversary in 1993 with a major international event. I have toured the university's Department of Mining Engineering and Centre for Resource Studies and have been impressed by the quality of the facilities and the people who work in them.

With regard to the Centre, I understand that the people there have had an excellent working relationship with the Ministry of Northern Development and Mines. For this reason, I am particularly pleased today to announce the approval of a grant to the Centre for Resource Studies for an amount not to exceed $81,525. This grant is in response to a research proposal entitled "Towards More Efficient R&D in the Ontario Mineral Sector". This is an important initiative and I want to congratulate Professor Alan Green and Ann Green on a successful proposal.

The Mines and Minerals Division of the Ministry of Northern Development and Mines is, in many ways, at the hub of technological change in the mining and mineral exploration industry. Our many problems and activities are testimony of this:

Last fall, the Ministry continued its airborne geophysical survey project, with five new magnetic and electromagnetic surveys in Northern Ontario. The surveys are part of a $10-million, five-year Airborne Geophysical Survey Program which began in 1987, and is supported by the Northern Development Fund.

It is interesting to note that Ontario-based companies are recognized as world leaders in this field. Airborne surveys provide a fast and accurate method of evaluating mineral exploration potential in areas where the geology appears favourable to mineral deposits. New maps will be released in the spring and summer.

As most of you are aware, each year my ministry, through the Ontario Geological Survey, funds the Ontario Geoscience Research Grant Program. This program not only assists individual university research, it also helps to greatly augment Ontario's mineral resource database.

My ministry has also taken another step toward the expansion of its Computerized Mining Lands Information System (CLAIMS). Once the CLAIMS system is in place across the province, information on unpatented mining claims will be up to date and accurate. With advanced technology, CLAIMS will also offer significant improvement and enhancement in services to prospectors, exploration companies, mining companies and the public.

The excellent work of our Ontario Geological Survey, our Mineral Development and Lands Branch and our regional organizations represents an

on-going commitment to helping the industry find and develop Ontario's resources. The interest in the results presented at our annual symposiums, certainly proves, I think, the value of this work.

I am especially excited about the announcement of the new $50 million Mineral Research Centre at Laurentian University in Sudbury. This centre will be completed by the summer of 1991. It will be used not only as a home for scientists from my ministry, but will as well serve as a base of cooperation between government, industry and academic officials.

These initiatives are all designed to support and encourage an industry that is itself becoming more productive.

But this industry can only function as well as legislation governing it will allow. This is why – in light of the many advances made in the industry in recent years – it became crucial to modernize provincial mining regulations and make them more attuned to today's needs.

After 73 years, Ontario has new mining legislation, just in time for the 1990s. In preparing Bill 71, our ministry personnel have been consulting and listening to prospecting professionals and other concerned people. Last December, Bill 71 received Third Reading and Royal Assent.

The original act was written in the first decade of this century. It provided us with the framework upon which to build a plan for the future. It is timely and appropriate for the provincial government to be providing the industry – as we near the end of the century – the necessary encouragement, impetus, and stability that a new, modern act – tailored to today's industrial needs and sensitive to emerging environmental concerns – can offer.

Changes in the new Mining Act focus on four broad objectives:

1. the need to act on Ontario's desire for environmentally-sound development of our mineral resource wealth;

2. the need to update staking and assessment requirements to match the modernization and technological development of Ontario's mineral exploration and mining industries;

3. the need to maintain a healthy investment climate; and

4. the need to more fully realize Ontario's mineral wealth by encouraging the maximum use of our resources.

The new Act also takes a responsible approach to respecting environmental concerns and being sensitive to the needs of mining communities.

As Minister, it is crucial that I have access to the technical know-how and the political insight to effectively address the questions of sustainable development in Ontario's mining industry. Last week, I had the opportunity

to participate in the environment conference, Globe-90 which was held in Vancouver. I was heartened by the high level of debate and by the priority placed on this issue by many of our senior mining executives. Clearly, balancing the development of new mineral resources with increasing environmental sensitivities is the greatest challenge facing our industry today.

Mining and its related industries contribute almost $8 billion a year in new wealth to Ontario's economy and employ more than 80,000 people. Ontario, in its own right, is one of the top 10 mineral producers in the world.

To maintain this position we must depend on the industry's capacity to grow and prosper and to develop the competitive edge required to lead in the fast-changing world marketplace. As I have outlined, the people needed to maintain this edge must be technologically innovative, environmentally sensitive and increasingly open and flexible to new government legislation and changing world conditions.

That's quite a tall order. But I have confidence that the educational institutions of this province and my colleague, past Mines Minister and current Minister of Education, Sean Conway, will continue to give this particular issue the priority it deserves.

As well, I am continually heartened by the willingness of industry to become involved in the educational process. Executives from Falconbridge and Denison, for example, have played a major role in the continued existence of the Haileybury School of Mines. And last month Inco donated $1 million to Queen's for the purchase of mining engineering equipment.

These examples serve to illustrate that with a positive attitude and a willingness to support opportunities for the future, industry and educational institutions can build upon their existing levels of co-operation and form new partnerships. Recent figures released by the Mines Accident Prevention Association of Ontario further demonstrate the effectiveness of this principle. They show that the Ontario mining industry achieved the lowest injury rate ever recorded in its history. I am told that mining now has a lower rate of lost-time injuries than the average for all other industries in the province. This, I feel, is confirmation of a successful team approach.

I am confident that by maintaining a high-level of cooperation in all areas, we can move forward to ensure Ontario's future in the global mining marketplace.

Digest of Discussions

Moira Jackson

While very wide-ranging, the discussions tended always to come back to three major issues: the nature of the mining industry and its consequent image problems, career paths for professionals and skilled tradespeople and, particularly, education and training. Each was generally seen to have a mutually reinforcing relationship with the other two.

The discussions of each element also typically turned from analysis of the problems to their implications for strategic planning, both for the industry as a whole and for the individual firm. The participants clearly viewed the question of human resources as integral to the future prospects of the industry and as an essential element of strategic planning that has not been given its proper priority in this process. The challenge was to get the industry as a whole to treat human resource planning as an essential ingredient in effective strategic planning. The issue is one of resource commitment, and other industries may be committing more resources to workforce development in anticipation of an imminent shortage. The mining industry needs to develop a strategy which will position it to compete effectively for a declining supply of skilled employees at all levels.

Nature and Image of the Industry

The mining industry is a working world like no other, with special constraints on its freedom of movement and choice. It operates in an increasingly global market, where its competitors do not always play the game by the same rules. Since mining and mineral processing are highly capital-intensive and equipment is becoming more and more complex and expensive, these activities are rapidly becoming the preserve of large companies or, at least, joint ventures between juniors and major firms. Operations are widely dispersed and are usually located far from major urban areas, and most mines have a finite life, usually of less than twenty years. These circumstances create their own difficulties, particularly in attracting people to work in the industry. In fact, northern locations and the cyclical nature of the industry were cited as

the chief impediments to recruiting and as factors which will become increasingly significant.

While there was some spirited dissent, the mining industry was overwhelmingly considered to be cyclical, with all the disadvantages that this implies for any industry, plus some others not experienced by other cyclicals. Most agreed that it is not reasonable to compare mining with nursing and teaching which, although they experience cycles of high and low demand for personnel, do not have to contend with the image mining has in employment.

The consensus was that, despite mining firms' planning efforts to mitigate the effects of cyclicality, it will continue to be a major characteristic, and hence a major influence on the industry's ability to attract employees. The industry has a reputation for hiring at all levels during the upturns in the business cycle and cutting costs during the downswings by layoffs of both production and management people. The latter have typically been less likely to be laid off, on the grounds that the company has more of an investment in them, but this is gradually changing as the jobs of production employees become more sophisticated and require more training.

There is a great variation in the types of operations being carried out in Canada. They range from older mines for which it would not be economical to update the production technology, to newly opened mines or those with large enough deposits (and therefore long enough anticipated lives to make intensive mechanization worthwhile) which are using the very latest equipment. Each type of operation has its own unique characteristics and requires different skills, and there is perceived to be a present or potential shortage in nearly every area. Even in some older operations, methods have evolved sufficiently that work is carried out very differently than it was twenty or thirty years ago. It is no longer possible to go into a mine at the age of 16, with only a few years of schooling, and do the same job until retirement.

Mining covers such a broad range of techniques under such widely varying circumstances that the industry needs both specialists and generalists with good fundamental knowledge who can take an overview of any kind of mine. Most people tend to specialize, which is fine for large companies which use the team concept, but smaller companies, which cannot afford the team concept, need broad-based geologists and engineers, as well as production employees capable of working in a number of different capacities. The discussions of these notions of generalist professionals and multiskilling are set out more fully later on.

The scope of industry activities is also very heterogeneous, as reflected in the discrete nature of its professional associations. These tend to be professional education groups, rather than a business group; there is no real analogue in mining to the Canadian Manufacturing Association, for example. The Mining Association of Canada and the provincial mining associations are groups of member companies; the Canadian Institute of Mining, Metallurgy

and Petroleum represents a broad range of technical and professional people for several different industries. Covering such specialized constituencies and with no umbrella organization to speak for them on issues of common interest, these bodies do not have the clout of, say, the national medical and legal associations. Since the mining industry also lacks a comparable system of accreditation, it has little means of control over university or college curricula and trades training programs.

Initiatives in training and education are made difficult by the division of responsibility for these areas, and for mining legislation in general, between the provinces and the federal government and from one province to another. While the prospect of coordinating actual mining legislation among the provinces is unlikely, it *is* possible - and probably essential - to work at improving coordination among the various government departments, such as Employment and Immigration Canada, the federal and provincial ministries of labour, and the provincial ministries that are responsible for such matters as mines, education, and skills development. Any such cooperative effort should also include mineral industry employers and labour groups. It was noted, however, that the industry tends to be very conservative and that it has an ambivalent attitude to government, on the one hand wanting to receive favourable decisions and legislation, but on the other wanting to preserve independence and maintain control over its activities.

Another reason for concern on the part of the industry is that political decisions on issues that affect its future, such as support for economically depressed regions, are often taken on the basis of votes. It was observed that, while the geographic areas most affected by mining-related policy decisions may be sparsely populated northern constituencies, the power may lie with city (southern) politicians who are more concerned about re-election on an environmental platform than on keeping industry going in the north. Environmental issues are popular with the electorate and it is easy to take hard-line positions on them in regions where people's livelihood is not affected by the resulting regulations. It was speculated that the industry is in for a difficult time in this regard.

Public concern over the environment is also a major contributor to the industry's poor image among young people as a potential employer. Image is very worrisome for the industry, particularly as it seems to have worsened over the past ten years, while the industry believes that the reality of its performance is quite the opposite. The public's perception of mining's working environment is another image problem for the industry. Mining is still pictured by many as a terrible place to work, for a number of reasons. Besides the perception that miners are "rapers and pillagers" of the earth, the industry must combat a reputation for dirty, dangerous work that offers neither job security nor status. The consensus was that it is up to the industry

itself to change this image in order to attract and keep the bright, energetic and technically competent and trainable individuals that it needs, to compete in an increasingly high-tech world.

A number of practical suggestions were offered as ways of accomplishing this process of informing the public about the reality of the mineral industry as a corporate citizen and as an employer. The theme most frequently repeated was the need to actually show people what mining is, with specific emphasis on showing teachers. Both the Ontario and B.C. mining associations have, for several years, run programs to bring secondary school teachers to active mines. This has been successful in changing the impressions that the visitors had of mining as a career before they saw the reality for themselves. It was considered especially important to make this type of contact with science and geography teachers to show them what career opportunities mining offers to their students and how to incorporate real-life occupations into their course material. The most significant group, however, is guidance teachers, who are seen as completely unaware of the nature of, or scope for, careers in exploration, mining or mineral processing. The experience of those who conduct these tours is that most of the teachers who participate are surprised by the degree of technology employed by the industry, as well as by the difference between their expectations and actual working conditions.

One way or another, it is clear, the industry must go out of its way to make itself appealing to high-school students, particularly before they make irrevocable course choices that will foreclose whatever further training and education will be necessary on graduation. The Western Australian School of Mines carries the mine-visit program even further than the Canadian provincial mining associations, chartering planes to bring the students themselves to mine sites and give them a realistic impression of the industry. The Chamber of Mines Residential Course brings 25 students to Kalgoorlie for a week during which they visit mine sites and spend the evenings with young mining graduates. The University has also mounted an ambitious scheme which has its staff and industry representatives visit schools to talk to students about careers in mining. In the U.K., the Mineral Industry Manpower and Careers Unit offers a number of services to bring the industry's messages into the schools. (These services are set out in Appendix II, which reproduces one of the Unit's brochures.) The British Coal Board has also run a one-week residential course at a university for 20 to 40 high school students which has proved to be an effective way of influencing young people.

Career Paths

Discussions of career paths for both professionals and production workers invariably included the notion of job security, which was seen to be the biggest single concern among employees in the industry. One participant observed that his industry pays lip-service to the idea that "people are our most important resource", but has not lived up to it. Rather, the prevailing approach is to regard labour as a commodity, as one more input of which the company buys what it needs at the time, like raw materials or electricity, instead of seeing its human resources as an investment. It was agreed that it is necessary to take a longer-range view and to develop a better understanding of the rights and contributions of all parties.

This led to the concept of a "social contract", a concept more commonly accepted now than it was only a few years ago. The industry's traditional way of coping with the business cycles has been layoffs and shut-downs, but several participants made the point that there are better ways of controlling costs, such as early retirements, reorganizations and rationalization. Temporary layoffs, however, are becoming much less socially acceptable. Not only is it now seen as less valid to differentiate among employee groups, but it is a fact that *all* skills are scarce and becoming more so.

Employment in the industry was 180,000 in 1980; by 1990, it had declined by 25 percent to 110,000. It was noted that jobs are created by finding new orebodies and by the introduction of new technology, and are lost by closing mines as well as, paradoxically, by new technology. Most of the reduction was due to mine closings and corporate reorganization; some rationalization has been done, but the impact of introduction of new technology and new methods has yet to take full effect. As these innovations occur, control of the size and cost of the workforce will become manageable in more acceptable ways than companies have used hitherto, thus improving the security of the surviving jobs.

The industry does itself a disservice in not retaining people during the downturns. The question, of course, is how to avoid hurting itself in this way, as it is a matter of balancing the loss of valued employees against corporate survival. As well, one industry participant stated that they owe it to their best-quality people to see that they are kept; another said that this is being done in his firm. The fact remains, however, that the industry does have to cope, not only with the down-side of the cycle, but also with people who can not be retrained any more. They are there every year, even if in smaller numbers. One participant said that his firm has simply adopted the philosophy that it is necessary to make the investment in retraining as long as possible and then offer early retirement, and "accept the effect on the bottom line."

It was suggested that the whole process could be managed more effectively if companies designed better career paths, not just for professionals, but for production workers as well. The industry's treatment of engineers, however, was singled out for special criticism, although it was agreed across the spectrum of sectors represented at the seminar that the mining industry merely reflects the North American attitude to engineers.

Several participants from industry and from different university disciplines observed that North America does not value engineers, and that this is reflected in the marketplace, which does not reward people for continuing to work in the profession. The earnings of engineers have not even kept pace with inflation. It is typical in a mining operation for the chief engineer to be the lowest paid, earning substantially less than operating superintendents, a practice which produces credibility problems. Many are leaving engineering work to go into management. Since the industry is not putting any emphasis on the engineering aspects of engineering positions, people tend to move on to management or supervision rather than upgrade their professional skills. One professor noted that MBA programs attract a number of mining engineers who, on graduation, rarely return to the mining industry. A key factor in these moves out of engineering and into management is the industry's traditional approach of using people with an engineering degree to do menial tasks in mines. The industry was criticized for misusing both geologists and engineers by having them doing operations rather than doing jobs that require and make use of their professional training.

This approach has created a peculiar circular effect: having undervalued engineers to the point of using them for jobs for which they were overeducated, the industry compounded the error by concluding that most engineers' jobs could be done by people with less training and education. As a cost-cutting measure, companies experimented with having engineering jobs done by technologists. They learned that having technologists running operations did not work; for instance, engineering knowledge was necessary to ensure the quality of the ores being mined. It has been recognized that the experiment was a mistake, that the industry does need technical engineers over the long haul.

The limiting nature of a degree in mining engineering was also noted. A participant wondered why anyone would choose to go into mining engineering when he could probably do most of the same work and still have better job prospects by taking mechanical engineering instead. The answer was that someone who wants to run a mine must take mining engineering.

Another aspect of the North American treatment of engineers – one which is not limited to the mining industry – is the perceived need to give engineers some status outside management, but in many work settings, this is nearly impossible. An industry participant noted that his firm had looked at the dual-ladder concept, which not only considers pay but gives status as well.

This is an approach which has apparently been very successful at 3M Corp., but in an organization where operations are so dispersed, it is very difficult to implement effectively.

The industry participants expressed frustration at the fact that they make an investment in a young engineer and then lose it after four or five years when he leaves for different work rather than upgrade his education. The result is a grave shortage of people with moderate experience and upgraded education, a shortage which causes accidents through technical failures. A wry remark was made about the fact that companies are willing to make huge capital expenditures for which they do not see a reasonable return because they lack the appropriate people to ensure that this expensive equipment is used properly. In brief, the conclusion was that the industry will no longer be able to recruit or retain engineers if they are expected to do menial work.

There was a parallel in this discussion of engineering roles with the exchanges about skilled trades: it was noted on a number of occasions that, as technology gets more advanced, the work boundaries of the trades are not always clearcut, that they often overlap as mining and mechanical engineering do. While the labour belief is generally that skills deteriorate if specialized tradespeople are required to learn more than one trade, a common industry viewpoint is that they must consider what they want the trades to be, and redefine the skills and, hence, the labels.

The broad issue of multiskilling came up frequently during the seminar, not just after the panel discussion on the subject, because it has implications for so many aspects of human resource planning. Advocates of the present system of trades accreditation believe strongly in strict segregation of skill areas. Their reasoning is that it is better to become top-notch in a single skill than to try to develop two or more skills, which would merely produce an employee who performs at a lower level in several trades. Rather than take a well-qualified employee and try to train him in another field, it would be better to streamline and improve the trades training we already have.

On the other hand, several participants noted that it is difficult to categorize all jobs into neat compartments, and expressed the opinion that it would be tragic to categorize too finely. Instead, it would be preferable to develop people's skills, not necessarily certifiable skills, but those that would combine to make a good all-round operator. It was observed that flexibility in this area does not have to mean a reduction in the quality of work done. One industry participant pointed out that a company has to get the job done with the fewest possible people, and therefore cannot afford the number of employees implied by having specialists for every task. Every operation needs both specialists and multi-disciplined generalists at all levels.

Another aspect of the debate on multiskilling is the question of its applicability to job satisfaction. Industry is seen as having the responsibility for creating the necessary environment to challenge and reward employees,

and it was suggested that multiskilling is an excellent way to help address situations where employees need stimulation and variety to be more interested, and hence effective, workers. The trades advocate's response to this suggestion was that satisfaction is more likely to arise from a thorough expertise in a single field. He did acknowledge that there are areas where such rigidity is a disadvantage to all, noting that the autoworkers have rejected any multiskilling but that the USWA has taken a different position. The fact still remains, however, that a key difficulty in combining trades or upgrading skills lies in the collective agreement clauses requiring these to be done on the basis of seniority. Acting on this basis too often results in anomalies and waste.

One point on which there was much comment but little debate was the need to establish a truly national system of apprenticeships and trades training and standards, with career development paths that let people see clearly the road to the top of their profession. It is a source of frustration to both management and labour because the present system of provincial apprenticeship and trades certification without common standards is disadvantageous to all. In the case of a company which is preparing the closure of a mine in one province, it is not always possible to offer jobs to the displaced employees in another of its mines. If the other mine is in a different province, they may very well lack the qualifications to be certified in the other province. Employees' mobility is limited by the same regulations if they should want to change jobs. What is clearly needed is a coordinated system that will enable people to transfer skills and certification among the provinces, at all different levels, not just the master level. It was emphasized that it would be essential to change direction carefully in order to accomplish the new system coherently, rather than in a piecemeal fashion.

Education and Training

Of all issues considered at the seminar, questions of education and training were seen as the most important by a wide margin, and occasioned the most concern and outright frustration. The frustration derived from several sources, but primarily from the universal sense that those most dependent on good policy in these areas – employers, as well as educators and students at certain levels – are being disadvantaged by systems that do not perform to acceptable standards at any level of education or training.

Secondary Education and Trades Training

In support of their criticism of the Canadian educational system, participants from all sectors pointed to illiteracy rates. Four percent of the workforce are completely illiterate and 18 percent are functionally illiterate. Numeracy skills are also at abysmal levels, and drop-out rates among secondary school students and in trades training are very high. Canadians are behind most major industrialized countries in these areas, and it was a generally held belief that we need a serious push even to regain lost ground, much less improve.

Improvement in education systems was seen as absolutely essential, in view of the changes in the industry as technology becomes more advanced, thus requiring employees to be even better trained and educated than before. Furthermore, demographic trends argue that the situation is inevitably going to get worse. With an aging population, fewer people are entering the workforce, and of those who do, there is a declining proportion who have been adequately prepared for the further education and training that they will require over their working lives. The most commonly cited example was the lack of emphasis in secondary schools on the courses that students need to be able to work with advanced technology. Most Canadian jurisdictions require only two or three credits in maths and sciences for high school graduation. However, even an entry-level job in mining now requires grade twelve maths and science. As a result, students who might be interested in working in the industry are putting themselves out of the running very early on by not taking the necessary courses. This point re-emphasises the importance of informing guidance teachers about the industry and its academic expectations. It also underlines the need, discussed earlier, for the industry to reach out to students at an earlier age, to go out of their way to give high school students the proper perspective about career prospects in mining and mineral processing.

A further deterrent to working in mining as well as in many other industries is a cultural one: many students are discouraged, either actively or by implication, both by their parents and by guidance teachers from entering apprenticeships and other trades training programs. The emphasis in guidance offices is on those students who will be going on to university, and status-conscious parents believe that their children should be aiming for academically oriented rather than technically oriented careers. Both groups, it was felt, are reacting to inaccurate stereotypes, and it is up to the industry to correct the misapprehensions through more contact with both students and teachers.

There were several practical suggestions as to how this might be accomplished. Besides the mine-visit programs already being run by the Ontario and British Columbia mining associations, it was felt that the most useful impact would be made by a careful selection of targets for this education

process. Participants from all sectors agreed that a campaign of information on mining careers would have the most impact in high schools in areas already economically dependent on resource industries. Specific suggestions included having mining operations make a "twinning" arrangement with local high schools, to increase awareness among the students and their parents.

One participant with professional ties to both the industry and academe observed that making education public had moved trades skills training out of private organizations and into the high schools. In the process, the quality of training deteriorated. As the bureaucracy took over, industry lost control over both methods and content of teaching, and hence lost interest in the process and lost faith in the system of training. It was suggested that industry must reawaken its interest and, as a consumer of the product of the educational system, begin to assert its right to some influence over the process that is producing its employees. It must take the initiative and remove the bureaucracy from training to get the proper skills and mix.

Inco's cooperative effort with Cambrian College (as described by Parker and Shannon) was cited as the ideal model, one of self-help that served more than just the company's needs and self-interest. The fact that the Cambrian program received more than 600 applications with no advertising implies that genuine interest exists in mining careers, and also reinforces the wisdom of targeting students in established mining areas. In addition, it supports the idea that the provincial mining associations are on the right track in educating "outsiders", especially teachers and others of influence, about career prospects in the industry.

Universities

Many of the comments raised in the previous section, such as the inadequacy of secondary school education and the need to make students aware of mining as a career, applied equally to the concerns about university education, but there were several others that related exclusively to the education of professionals. The decline in enrolment across the country – indeed, around the world – in mining engineering programs and earth sciences is a major problem to universities. The concern is not simply self-serving interest on the part of academics in preserving teaching and research jobs, financial resources and power within the institution. The hard fact is that university administrations are too squeezed for resources to allow any to be wasted on programs that are no longer in demand. If one department is expending its allocation on fewer and fewer students and another is stretched beyond capacity by increasing demand, it is only a matter of time before the resources are shifted to the areas where the administration believes they will be used to

best advantage. Once a department has lost credibility and funding, rebuilding will be extremely difficult if trends should reverse themselves and interest in its programs begin to grow again. Restoring its finances, recruiting faculty and rebuilding its reputation would take several years and, in the meantime, students might become discouraged by an inferior educational product that is the direct result of inadequate investment.

Experience in the U.K. has shown that rationalizing university mining programs by closing some and redirecting potential students to those remaining has only further reduced the total number of students enrolled and has not substantially slowed the decline in enrolment in those which still exist.

The issue of declining enrolment involves several factors. One which overlaps the discussion in the previous section is that of the industry's image as an unappealing career choice, as a fair-weather employer offering little or no job security. Professionals are particularly likely to be discouraged by the prospect of working in remote locations that offer few opportunities for employment or career advancement for their spouses who are likely to be professionals as well, probably female and therefore less likely to be interested in a career in mining. The industry should be looking seriously at the opportunities being neglected here, such as the untapped pool of potential employees - females – and, hence, the possibilities for recruiting dual-career families.

As with the problem of attracting secondary school students into mining-related trades training or community college mining programs, mining is experiencing difficulty in inducing engineering students to choose mining as their specialty after the first year of general engineering. The industry's problem is exacerbated during the cyclical downturns, when they are hiring few new graduates. Seeing limited prospects for themselves on graduation, students understandably take a short-term view and opt for a more marketable specialty after first year. By the time they graduate, the cycle may well have turned around, but by then it is too late for the industry. They will have lost a number of potential mining engineers and will have to wait at least three years for the next group of graduates.

The challenge for the industry is to demonstrate to young people that mining can provide an interesting, rewarding and secure lifetime of employment. This is not to say that lifetime employment should be guaranteed, as in the model of some Japanese companies, but that new graduates should be able to feel some confidence that dedication and performance will be recognized and rewarded. They may not spend their entire working lives in the mining industry, but should be able to find it relatively easy to move in and out as the cycle makes its swings.

Several proposals for dealing with these problems were advanced. The Western Australian School of Mines has tackled the problem from a number of different angles, all of which are designed to change the public image of

mining. Central to their strategy is a well-designed communication program which includes advertising on national television and the high-school residential program, along with prestigious scholarships. The purpose of the advertising is partly to attract the interest of students, and also to bring home to their parents that the industry wants good performers. The scholarships are advertised nationally and are awarded after an extensive competition that includes three days of interviews. A panel of 12, mostly CEO's, evaluates the candidates. Most of the scholarships are sponsored by more than 20 mining companies, and are very generous; three sponsored by the Department of Mines provide $4,000 per year for the first two years and $7,000 for each of the last two years.

In Canada, the lack of interest in university programs related to the mining industry is also reflected in a low and declining demand for industry scholarship money. It was suggested that, since summer jobs are the key to attracting first-year students to mining as their specialty in second year, the industry should combine scholarships with summer jobs. Even better would be a combination of scholarship money, a summer job and a mentorship program, as the latter would also help resolve some of the perceived problems with career paths and professional development. In this context – as in several others – it was observed that the industry is fragmented and must coordinate its efforts to get its share of engineering enrolment. The campaign mounted by the former head of the department of mining engineering at Queen's University, to induce mining firms to offer summer employment to first-year students in an effort to introduce them to what the industry has to offer as careers, was described as being good as far as it went. Nevertheless, the commitment by the firms that participated was vulnerable to economic stresses and the consequent unpredictability of job availability tended to perpetuate the industry's reputation for lack of employment security.

Another aspect of the issue of education of professionals for the mining industry is the question of management training for engineers. There was general agreement that mining graduates must be educated and trained to be good managers – not just technical managers, but business people. They should be able to see their own jobs and their operations in the context of the larger organization and its goals, constraints and opportunities. To be able to do this, they need to be taught about such matters as human resource management, accounting, environmental management, risk management (e.g. selling gold forward as insurance). A typical engineering student will take three credits in engineering economics; it was suggested that this could be extended to cover more business-oriented courses, designed specifically to meet the needs of graduates who, as mine managers, will essentially be managing a business. An analogue is a mining science program for accountants.

A recurring theme was the need for active cooperation between the industry and business schools. The responsibility for any such initiative was seen to be shared between the industry and the universities. It is the obligation of educators to bring education and practice into close proximity. This means that the universities will have to talk with their industry colleagues; if they are going to offer a service, they have to be sure that they understand the needs it is meant to fill. However, it is equally important that the industry understand the limitations on what universities can do.

A particularly serious gap in the system is the shortage of people who can deliver management education in specialized fields. The Ontario Government chairs in mining engineering departments go a long way to filling the gap in some of the technical areas of professional mining education, but there is no comparable initiative to fill the void in the equally important field of management education for the mining industry. The logical solution to this problem is for the mining industry to establish chairs in some of the major Canadian business schools. Universities like Queen's and U.B.C. with respected business schools and well-established mining departments would be the most appropriate locations for such chairs.

As with secondary education, the graduates of university programs came in for criticism, and not just for the paucity of their knowledge of management techniques. The conclusion was that major changes in university mining programs are necessary because, in general, they are producing "very poor people" at the undergraduate level. The Engineering Council in the U.K. is apparently moving away from specialization at the undergraduate level to a degree in general engineering. The result seems to be a highly mathematically competent engineer who understands physics and can readily be educated further in a specialty. This not only leads to a higher calibre of engineer, but also offers the graduate more career choices and does not lock immature or uninformed undergraduates into a path that they may regret in the future.

Universities were also criticized for their lack of flexibility. Much of the internal lack of flexibility is unavoidable, as indicated in the discussion of the dilemma of how to deal with declining enrolment in a particular department. Nevertheless, it was felt that there should be considerably more cooperation among departments in terms of developing courses that could serve students in several disciplines and encouraging inter-faculty programs. The Master of Industrial Relations program at Queen's University was cited as a good example of such cooperation, as students take a combination of courses in the School of Business, the Law School and the Department of Economics.

The degree of external flexibility received much less sympathy. Universities are seen to be inflexible in their dealings with the industry, and to be far too rigid in their treatment of community college graduates who wish to upgrade their education. It was considered especially unfair that college

graduates should receive few, if any, credits for their college courses if they register in a university degree program.

Continuing Education

There was no argument from any quarter about the need for continuing education and training for employees at all levels of an organization. Ironically, a frequent complaint from industry participants was that their companies do not seem to recognize this as a priority. Several pointed out the lack of money for management education when money *is* available for hard resources.

All participants agreed on the need for extension courses of some sort. It was noted that the USWA does a good job of this for the production workers in Sudbury. For management, the options are very limited. The large companies do send some people on short courses offered on-site or at universities, but these are not courses which will lead to advanced degrees or professional accreditation. For small operations, extension courses are non-existent. They have employees who would love to take them, but long distances from the institutions make it all but impossible, since nearly all programs require the student to be on campus. The question of where to offer short courses did prompt some debate. Two academics who have had extensive consulting experience in the mineral industry had opposite views, one having found that courses can be operated efficiently in an on-site program, and the other believing that there are too many distractions if the students' jobs are handy and that it is therefore better to remove them physically from the workplace.

In response to an observation that remote locations seem to argue in favour of correspondence courses, the experience of the Institute of Canadian Bankers was cited. The Institute has had a longstanding program that is driven by accreditation and relies on universities across the country to mount non-credit (for the university) courses designed to their specifications. Attempts were made to offer the courses by correspondence, but the difficulties were serious enough that this approach was abandoned. It was suggested that such an accreditation program could serve the mining industry well, as long as it avoided the impression of requiring its students to "jump through hoops".

Another possibility for dealing with the remoteness factor seems to be distance education via video-teleconferencing. Mr. Hennebury commented that BNR's technology is now much improved. Even after the costs of installation and training, the company saw a $7 million reduction in travel costs. They found, too, that people who used the system preferred it to

"hanging around airports in a snowstorm". A Northern Ontario program for education tried video-teleconferencing, but found it expensive and inflexible (with the need for studios, pre-booking, etc.) and decided that it would be feasible only if the government purchased a network. They were expecting to have achieved genuine flexibility and cost-effectiveness by mid-1991.

Where Does the Responsibility Lie?

It was generally agreed that it is the responsibility of professional associations to deal with all these issues. In fact, it was stated several times that it is imperative that they recognize that the responsibility lies with individuals, companies, and the industry as a whole, and that industry associations must be the delivery system and act as coordinator and champion of whatever action is decided upon.

Despite the fragmentation of industry associations noted earlier, the CIM was seen as the natural agency to pull all this together. Since most of the participants were members, any action deriving from the seminar would have to come from them. While agreeing that the CIM should take some concrete action, there was some doubt that it could bring its diverse interests to focus sufficient energy on this problem. Another expressed the opinion that any CIM initiative would almost certainly turn out to be primarily technical although it was clear that this was only one aspect of the overall problem identified during the addresses and discussions. Nevertheless, there was a consensus that the CIM should be a prime player in any action that followed from the seminar. And since the industry is so heterogeneous and the professions that it comprises are so discrete, The Mining Association of Canada is needed as well. The MAC, as an organization of companies represented at senior management levels, has the ear of the industry and also speaks for the industry. And, working as full-time professionals, MAC would likely be more effective than volunteers who must wrest time from their regular work to donate to CIM affairs.

What to Do?

This seminar was organized because of concern within the industry over the availability of its future manpower needs, and concern within the university community about declining enrolments in mining-related programs. It is clear that, before any action is taken, it is necessary to find out if perceived shortages are real or if enrolments merely reflect changes in the companies' requirements. For example, are engineers what the industry really needs?

The statistics presented during the course of the seminar are history, and we now need data for the future. In order to make plans, the industry needs hard information to provide itself with ammunition before engaging in any discussions or planning with governments or educational institutions. Therefore, it was unanimously agreed that a good scientific human resource study that includes some modelling of future needs is an absolute necessity. Then a wider industry-government study should be undertaken. And work should begin as soon as possible, in view of the long lag time – at least five years to mount programs and produce graduates – between identification of needs and the availability of people to fill them.

Once concrete information is in hand, the industry and the universities and other institutions must work together to design courses and programs that will produce trades and engineering graduates who will find satisfying and productive careers in mining. This activity will be particularly important in the field of management, which will require the industry and business schools to jointly offer extension courses.

Two suggestions by industry participants were the establishment of a mining institute of management and the possibility of twinning a company with a university or a college. The idea of industry chairs in existing business schools was seen as superior to a separate institute, since there could be two or three across the country, which would improve access in view of some of the great distances involved. The Inco/Cambrian model was noted as an example of the success possible from the "twinning" proposal.

Whatever the findings of the human resource study with respect to engineers, there was great support for the notion of improving recruitment into university earth sciences programs. Even if the universities do overproduce in terms of mining industry needs, there are many careers for geoscience graduates outside of mining.

As to making the industry more attractive to potential employees, it was agreed that, collectively and individually, companies have to attack the image problem, by talking to high schools – both students and teachers – by helping teachers make science more interesting, by demonstrating the challenges in the high-tech nature of the work, and by donating scholarships and/or chairs to targeted institutions. The notion of targeting should also be extended to recruiting activities in high schools and universities: recruiting should be refined, using a rifle rather than a shotgun approach to concentrate on the most likely sources of interested students.

Participants from both industry and academe agreed that it is up to educators to *put* themselves in a position to do something when industry needs help, something that the academics present believed that groups at universities would welcome opportunities for. There was also a clear consensus that universities must refine – redesign, if necessary – their programs and

dispense with the rigidities of their traditional structures. They were described as being locked into a conservative mode which is too specialized for the present needs of graduates and their employers. One specific modification they should consider is to have geologists, metallurgists and engineers all studying together, at least in the more elementary courses, to give each group a better understanding of the connections and overlaps among the different fields. The Western Australian School of Mines, for example, has been successful with a course in process mineralogy that brings students from all fields together.

Community colleges are perceived to be doing a better job of relating their programs to real-world needs and industry expectations. This is poorly done in universities in general, but there are "target-type" universities which would welcome opportunities to work with the industry on specific problems like continuous education. An exception to the perceived lack of response among universities is the University of Waterloo, which has benefited by having an entrepreneur as its president, and has an impressive record of seeing where the needs are and getting on with doing what is necessary to meet them.

Task Force

In the course of the closing discussion, there was a universal feeling that the seminar presented a unique opportunity to initiate some concrete action, that it was possible to accomplish something of lasting value if this opportunity were seized. The most effective procedure was considered to be the creation of a task force to press the industry to develop a strategy for education, training and career development. An Ad-Hoc Committee was formed under the chairmanship of Dr. Malcolm Scoble, head of the Department of Mining Engineering at McGill University. Members appointed were George Poling, Tom Reid, Dennis Shannon, and Margot Wojciechowski. This Committee's primary mandate was to seek the support of the CIM Council and the CIM Education Committee, at the Annual General Meeting in Ottawa in May 1990, for a national task force on human resource planning. The results of this and further efforts are set out in the Epilogue.

Conclusion

The consensus was that it was up to the industry to combat its image, as a dangerous, dirty, environmentally destructive employer with no job security or status to offer in order to recruit the bright, energetic and technically competent and trainable individuals that it needs. The presentations by

Professor Jones and Mr. Hennebury were particularly helpful in offering specific proposals for accomplishing this goal.

A number of thoughtful observations derived from the academics in the group, who covered a wide range of disciplines, from mine design and metallurgy to industrial relations and management of technology. Since the mining industry requires employees to do everything from the physical production to a fairly esoteric brand of economics, there is no simple solution; rather, this implies a great number of stakeholders, including individual companies, industry associations, unions, educational institutions from secondary level to postgraduate, provincial associations, chambers of mines, and government departments of mines, education and advanced skills. The mining industry must take the initiative both in giving feedback to educational institutions and in devising appropriate methods of providing in-employment training and enabling employees at all levels to upgrade their skills.

It is clear that instability in employment in the mineral industry is not going to go away and that the industry must meet the career expectations of its employees at all levels. Life-long learning, the knowledge explosion and the relentless advance of increasingly sophisticated technology are key features of the future in this industry. Changes in the way companies manage the size and development of their workforces are essential, and will require cooperation and teamwork among the stakeholders (those identified in the Morris matrix, as well as shareholders/investors, industry associations, educational institutions, and governments – the latter in view of the importance of the industry to Canada).

Advanced technology is going to require advanced training, and there is presently no adequate system for delivering even today's training requirements. This raises a number of questions, even beyond the obvious ones about the nature of the future workforce and the extent of basic and continuing education and training they will require: What are the companies doing and what are they prepared to do? Who is going to pay? What is going to be done about the interprovincial barriers in education and trades training? The question of employment mobility was a particularly important consideration in this respect.

It was agreed that a necessary starting point would be an assessment of the skills for which people would have to be trained and educated. CRS was suggested as the logical group to commission such a study. Besides simply gathering numbers and opinions, any study of the industry should pay attention to these issues, because they are the heart of matter and the raison d'être for the study. It is unmistakably clear that a national approach to training is needed, and that companies must start to plan the education and career development of their employees. Education, training and relocation of displaced employees are major challenges for all parties. The supply of the workforce is a management issue and should be regarded by industry as an

investment rather than a period cost. This is an interesting way to look at the links between industry and universities and colleges: what they are and what they might become with some imagination and cooperation.

There was also agreement that this study should be followed up by the formation of a task force whose mandate would be to come up with a plan of action and press for its adoption by the stakeholders. The support of organizations such as the Canadian Institute of Mining and Metallurgy and The Mining Association of Canada would be essential for the success of all these activities.

Epilogue

The seminar's Ad-Hoc Committee was successful in its efforts at the CIM Annual General Meeting in May 1990. CRS Executive Director Margot Wojciechowski presented the proposal to CIM Council and received an assurance of support. The CIM education committee also established a task force to deal primarily with the same issues at the professional level.

In June 1990, building on the momentum established by the CRS seminar, John MacDougall combined his efforts to acquire support from Employment and Immigration Canada for mining trades training with the broader focus of the seminar participants. A group of 20 representatives of government, industry, unions and academe (many of them seminar participants) were invited to a meeting in Ottawa to discuss alternatives for dealing with the complex issues involved in providing the industry with the manpower it needs. After a useful airing of views and sharing of knowledge, the group arrived at a consensus based on a proposal by Patrick MacCulloch. His proposal was based on two main premises: that the task was far too demanding to be done on a volunteer basis by an executive at the required level of influence, and that the action undertaken should involve all groups presently engaged in related activity.

The result was that Patrick MacCulloch was induced to take on the chairmanship of a "Launch Committee" which would design and recommend to the sponsoring institutions an outline action plan. The initiative would be industry-driven, but the cooperation of government and educational institutions would be essential to the achievement of any worthwhile outcomes. The Minister of Energy, Mines and Resources Canada offered the project his support, and some financial and practical assistance from Employment and Immigration Canada was found to be a possibility.

The Launch Committee comprised Glenn Kendall, EMR Mineral Policy Sector; David Gourdie and John Zenko, EIC Labour Market Service; René Dufour, École Polytechnique; Carlos Frewin, The Mining Association of Canada; Tom Reid, USWA; Yvon Bédard, Ministère de l'Énergie et des Ressources du Québec, who was replaced by Claude Drouin of the Quebec Mining Association; and Moira Jackson, CRS. In meetings in July and August, 1990, the Committee drafted a proposal for a specific plan of action for the industry initiative, with budget and time-table, and an organization that it was able to recommend as being effective for the task and supportable in principle by the various industry constituents.

The plan ultimately adopted, and now in progress, begins with a study of employment as it now exists in all sectors of the Canadian mining industry. This study will produce a factual and statistical basis for planning future education and training policies, which will be used by the steering committee in conjunction with the different industry and government groups to assist in the development of workable and effective training and educational programs.

The final plan was endorsed in January, 1991, by the three major stakeholders in the situation, The Mining Association of Canada, the Canadian Institute of Mining, Metallurgy and Petroleum, and the United Steelworkers of America. In a joint letter to the Minister of Employment and Immigration Canada, they requested that the Department finance and perform a Sector Study of what in the mining industry, including exploration and semifabrication. Such studies are carried out by independent consultants under the supervision of the Department, and under the direction of a steering committee made up of representatives of all groups with a direct interest in its findings.

The steering committee for the Mining Sector Study has twenty members, from the MAC, CIM and the Prospectors and Developers Association, academe (universities and community colleges), government and labour. With the assistance of EIC specialists, they have drawn up the terms of reference (which are set out in Appendix III) for the study. Once the contractor has been selected by a sub-committee of the steering committee, work will begin immediately and a final report will be presented in the spring of 1992.

In addition, the CIM approved and adopted the postgraduate study program proposals outlined by Klaus Konigsmann during the seminar panel discussion on continuing education.

Appendix I

Attitudes to Mining in British Columbia

Conclusions

1. The mining industry is seen as an important part of the B.C. economy, generating employment and economic activity. The industry is not "high-profile" currently, with limited public knowledge apparent. Economic return is currently seen to be slightly below average, and the industry to be neither growing nor contracting.

2. The image of the industry is improved by its economic importance, and by those perceiving its economic health as positive. The overall image is hurt by some impressions of economic softness, and concerns on environmental issues. Mining's image is below average on the Island, but higher in the South East and mining towns. Assessment is also lower among older residents, females, and below average income individuals.

3. The industry is seen to be concerned about the environment, and to be improving its performance in this regard. Positively, the industry receives better environment ratings in areas with more exposure to mining. However, there is a broad-based call for further attention and improvement by the industry, particularly regarding water pollution and reclamation. This feeling is strongest among those expressing a greater concern for the environment, and farming government control. Knowledge of government reclamation regulations does not have any correlation with the industry's rating on environmental issues. Personal perceptions of the degree that water courses are polluted or land actually is reclaimed determine opinions.

4. There is a strong level of support for future expansion of mining in the future, with only 5 percent wanting it to contract. There is a general perception of widespread good mineral resources in the province. By a margin of over three-to-one, the B.C. public supports exploration incentives. Currently, there is a broad sense of tax balancing incentives, and taxation levels being appropriate.

5. However, this support for the mining industry to expand is heavily dependent upon the industry being seen to pay due regard to environmen-

tal concerns. Only 20 percent believe the industry should concentrate more on job creation than protecting the environment, 50 percent looking for a short-term focus weighted in favour of the environment.

6. There is only very limited public support of exploration or mining in national or provincial parks, by about one in five British Columbians. Only one-third are in favour of such activities in designated recreation areas. Elsewhere, there is a broad outline support for mining being allowed, 60 percent near major cities, and over 80 percent in remote wilderness areas or areas other than parks. The creation of public access into previously inaccessible areas is seen as advantageous rather than the reverse by a margin of three to one.

7. The general public want the provincial government to have a significant influence on the mining industry. Ensuring environmental protection is a prime responsibility, along with incentives or other activities to ensure or develop employment. Only one-third are aware of there being regulations ensuring reclamation. Only 3 percent disagree that the government should do more to ensure land reclamation is completed.

Appendix II

MINERAL INDUSTRY
MANPOWER AND
CAREERS UNIT

Established in 1970, the Mineral Industry Manpower and Careers Unit, (MIMCU) is supported by various member companies of the Mining Association of the United Kingdom. Our initial work concentrated on manpower forecasting and liaison between secondary schools and university departments of mining engineering and mineral processing. In the mid 1970's several mineral oriented A level science enrichment projects were developed and the Unit began to provide a wide range of educational services. By 1979 the Unit was maintaining personal contact with staff of science and geography departments in over 1000 schools. During the last ten years the Unit has initiated some specific projects such as the Nuffield A level Special Study 'Mineral Process Chemistry' and participated in many broader curriculum developments including sections of Science in Society, Science and Technology in Society and Nuffield Coordinated Science.

With the current nationwide emphasis on curriculum development MIMCU is responding to the increased demand and need for such work by expanding the age and ability range of its cross-curricular materials and aims to be of use to a much larger number of secondary and primary schools .

Thanks to financial support from several metal mining companies, our residential courses for teachers and trainee teachers can be provided at no cost to the participants. Most pupils attending our applied science field days contribute a small daily sum to cover the use of reagents and other materials. Technical and administrative inputs to Local Authority in-service courses are provided free of charge.

ACTIVITIES AND SERVICES

ACTIVITIES

Some of the activities described below for teachers and students occur each term. Others are offered only occasionally. The schedule of activities for the current academic year is available separately on application.

COURSES FOR TEACHERS

1. Mineral Process Chemistry Induction Courses.

These aim to help teachers gain an understanding of mineral resources and associated industrial operations and to give specific advice on teaching these aspects of applied science. Originally these were designed for teachers who were embarking on the teaching of the Nuffield Chemistry A Level Special Study. However, since other syllabuses now contain earth science related topics the courses are also suitable for teachers of several A level and GCSE science syllabuses.

These weekend courses are usually based in the Midlands (Stoke or Derby and the Peak District). A typical timetable commences at 18.00 on a Friday and runs through to mid- day on the Sunday.

The programme includes introductory lectures by a lecturer in Mineral Processing, a quarry/plant visit, field work at our Centre in the Peak District and workshop sessions on the curriculum materials.

2. Courses based at universities or at the Cambourne School of Mines

The targeted group may be teachers of a specific discipline in one or more of the traditional sciences, geology/geography and/or careers teachers. Lectures, practical work and industrial visits introduce the mineral resources industries and their operations.

A session on degree courses and career opportunities is included. These courses are usually held mid-week out of university term time.

3. In-service training courses

'INSET' courses are arranged through a Local Authority and are arranged jointly by MIMCU staff and the relevant subject adviser. They are normally of one day's duration.The Local Authority arranges the release of teachers from duties for the day.

Following introductory talks by MIMCU staff and/or a representative from the industry to be visited, a visit to a local minerals extraction site is organised. This is followed either by a working session on existing curriculum material or by a planning session for the production of teaching materials relating to the industry visited.

The programme will vary according to local mineral resources and the subject disciplines of the participating teachers. Geology, geography and science teachers and others may participate in such courses.

COURSES FOR STUDENT TEACHERS

Science teacher trainees from university departments spend a number of days in the Peak District, accompanied by their tutors.

Activities will vary according to the tutor's requirements. Some time is spent on fieldwork at the Ecton Field Centre, a quarry/plant visit is included and curriculum material is introduced.

COURSES FOR SIXTH FORM STUDENTS

1. Science & Resource Engineering

These are for first year A-level science students and are usually located in the Mineral Resources Engineering department of a university. Lectures, visits and laboratory work are organised by university staff. These give an insight into degree courses which are available in the particular department. Applicants are expected to be considering the subjects offered as a possible future degree course.

Timing is arranged to be after the end of the university term so that hall of residence accommodation and university staff are available. The usual timing is the end of June or the beginning of July, for a three-day mid-week period.

2. One Day Activities at the Ecton Field Centre

This type of activity offers, for groups of sixth-formers with their teachers, an opportunity for a day of field work on a Saturday or Sunday through the Spring, Summer and early Autumn (in term time only).

An underground visit, surface reconnaissance, collection of minerals, tests on minerals and processing are included. These are run by teams of volunteer teachers and are generally most appreciated by students of chemistry and geology.

3. Other One Day Activities

It is possible to arrange special mid-week activities based at Ecton (near Ashbourne). These can be devised with MIMCU staff by applying to the Unit and can be oriented to arts or science groups.

SERVICES

CAREERS ADVICE

This is intended mainly for A level students who are considering a career in the minerals industry. Information on courses in higher education, qualifications needed, scholarships available and subsequent career prospects are provided in our literature. Individual advice is given where this is requested.

CURRICULUM MATERIALS

1. Mineral processing laboratory exercises, including those already included in the Nuffield A level Special Study, Mineral Process Chemistry, are available. The extraction of manganese from its ore is available from January 1989. Other, less thoroughly tested, exercises are available on request.

2. For the 11-16 year age range, two cross-curriculum packages are available, 'Let's Look at China Clay' and 'Let's Look at Sand'. During 1989 'Let's Look at Fluorspar' should be completed.

A group of teachers started work in September 1988 on a pack relating to the production of titanium dioxide. This is being produced with help and close cooperation from Tioxide, Grimsby.

The Extraction of Aluminium Sulphate from High Alumina Shale has now been incorporated into the Chemistry section of Nuffield Coordinated Science. Sections of 'Let's Look at Sand' are recommended as being complementary to the Glasses and Ceramics section of the above text.

Some projects have been adapted for use in Salters GCSE Chemistry.

3. Rock and ground ore samples and a few chemicals are provided at a modest charge for the A level mineral processing exercises and the 'Let's Look at ...' packs. High alumina shale is available from MIMCU for the Nuffield Coordinated Science exercise. The 'alum shale' from the Yorkshire coast is also suitable for that exercise.

4. Sets of slides with notes may be borrowed (and copied) for use with the curriculum materials or for use in other contexts.

Further information may be obtained from :

Mineral Industry Manpower and Careers Unit,
Prince Consort Road,
London SW7 2BP.
01-584-7397

Appendix III

Terms of Reference: EIC Sector Study

Study Background

This study results from the concerns expressed by a significant number of people both within and outside the mining industry regarding the industry's ability to attract an adequate number of appropriately qualified employees at all levels, from production to management. A seminar on human resource planning for the mining industry held in March, 1990, at the Centre for Resource Studies provided the momentum which lead to the formation of a "Launch Committee" in June, 1990. This committee of representatives from employers, unions, professional associations, government and educational institutions recommended, in November 1990, a thorough analysis to determine the nature and extent of the industry's human resurce requirements and the factors affecting those requirements.

The result of this initiative was a joint request by the Mining Association of Canada (MAC), the United Steelworkers of America (USWA) and the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) that a human resource study of the mining industry be undertaken by Employment and Immigration Canada (EIC). Such a study offers a pragmatic and collaborative approach for assessing the human resource situation of the industry and for developing a strategy for cooperative remedial action.

Study Process

While the study will be coordinated by the Labour Market Outlook and Structural Analysis Branch and sponsored by EIC, it will be under the direction and guidance of a steering committee of representatives from industry, labour, educational institutions and government. The steering committee for this study will be co-chaired by the Commissioner for Employers, Mr. Peter Doyle, and the Commissioner for Workers, Mr. Fernand Boudreau. The other 18 members of the committee will come from the following institutions: business (5 representatives), labour (4), CIM (1), the federal government (2), provincial governments (4), and universities and colleges (2).

EIC will play a secretariat role to the steering committee, providing data, when available, from EIC databases to the contractor conducting the study and will actively participate in the interview stages of the study.

The specific responsibilities of the steering committee will be

- to agree to the study plan put forward by the contractor, including steps, timing and responsibilities;
- to assist the contractor by supplying data, if available, and making contacts with individual firms, as required;
- to hold regular meetings on the substance and progress of the research;
- to resolve all key procedural questions during the course of the study;
- to guide and agree upon all aspects of the final report;
- to determine what follow-up action to the study should be undertaken.

The final report produced as a result of the research is expected to represent a consensus view on the future course of the industry. The final report is the product of the steering committee participants and hence, all the resources that are identified during the study process are to be used in serving the collective interests of the participants in arriving at their ultimate assessment. While the work of the participants on the steering committee is carried out within agreed-upon and shared confidences, the final report will be a public document.

The success of such studies depends on the direction, experience, insight, specific knowledge and dedication of all parties involved. Thus, the terms of reference establish a basis for action and implementation that industry and labour are prepared to carry out together.

Overview of the Canadian Mining Industry

Sector representatives favour a relatively broad definition of the industry for this this type of study. Thus, the "mining industry" referred to in this study is taken to include both metal and non-metal mining, coal mining, nonferrous metal smelting and refining, non-conventional crude oil extraction, and mine exploration services.

To put this study in perspective, it is useful to explain the importance of the Canadian mining industry to the well-being of Canada. The industry produced metals, nonmetals and coal worth some $18.7 billion in 1989. Metal products represented 77 percent of this production ($14.3 billion), while nonmetals accounted for 13 percent and coal some 10 percent. Through technological innovation cycles, the industry succeeded in developing an infrastructure and a labour force to assert a prominent presence on the world market. The Canadian mining industry is highly regarded for the quantity and diversity of its production as well as for the quality of its mineral resources.

With a production of more than 60 minerals, the Canadian industry is one of the world's largest mineral producers. In 1988, the Canadian industry ranked first worldwide with its uranium production (34 percent of the world production) and its zinc (19 percent), and second with its potash (26 percent), nickel (24 percent), titanium (18 percent), asbestos (16 percent) and gypsum (10 percent).

Also in 1988, the mining industry exported minerals worth more than $7.3 billion, representing some 5 percent of Canada's total export revenues. Metals accounted for 45 percent of the export balue, while nonmetals and coal accounted for 28 percent and 26 percent respectively.

In 1990, the Canadian mining industry employed 99,700 workers. The metals sector accounted for 46 percent of this workforce, with refining and smelting representing 31 percent. The nonmetals sector and coal made up 11 percent and 12 percent respectively.

The significant contribution of the mineral industry to the economy of Canada is greatly influenced by the dynamics and evolution of the international economy. The industry as a whole must find ways to cope with increasing global competition, the trend towards trade liberalization, and the growing importance of environmental protection. How successfully the mining industry will meet these challenges will depend on the industry's ability to incorporate advanced technologies and to attract and retain a highly skilled workforce.

Issues and Challenges Facing the Industry

There is a strongly held perception among many industry stakeholders that Canadian mining is facing a serious problem in meeting its future human resource needs. The extent and significance of the problem, concerning the availability and quality of human reources, could seriously limit the ability of the Canadian industry to compete globally. Concerns have also been expressed about a potential shortage of qualified workers, graduates and entry-level workers.

These shortages are believed to be occurring in a number of key occupations, such as mining engineers, geophysicists, metallurgists, heavy equipment operators, technicians, technologists and management. Many stakeholders have pointed out, however, that little is known, in fact, about the *extent* of current and expected supply and demand across skill and occupational groups, and about the factors underlying the supply/demand imbalances - if any.

The mining industry is becoming increasingly technologically demanding at all levels of work. A survey conducted a year ago by Statistics Canada on the diffusion of technology in the mining industry[1] revealed that over half of operating mines, representing 85 percent of the total employment in the industry, are using advanced technology and/or applications in their operations. Significant growth is also planned over the next three years in many of these advanced technologies.

It would appear that the mining industry will have to prepare for higher requirements in education, training and recruitment standards to ensure that it will be able to cope with the new and increasing demands for skills and talents. The upgrading of the technical, professional and mangerial capabilities of workers at all levels of the industry is extremely important to maintain a highly qualified workforce. The mining industry's ability to meet the challenges of a workplace where equipment automation and robotic technologies are becoming more common will affect the industry's financial success and pre-eminent place in the world economy.

Another issue for the industry is its competitiveness in attracting and retaining appropriately qualified people. The mining industry is already competing with many other industries for similarly skilled employees. This competition could become even more difficult, given that the pool of such employees is expected to become substantially smaller within a few years. Even within the industry, the northern remote mines are at a competitive disadvantage to the mines situated in more developed areas further south. The differing standards for trade qualifications among the provinces make worker mobility difficult, both within and outside the industry. The cyclical nature of the industry and its environmental impacts may adversely affect the industry's ability to attract qualified employees at all levels.

By addressing these challenges and issues, the mining industry would lay the groundwork for maximizing the development of one of its key components, human resources, towards the en- hancement of its global competitiveness.

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[1] This includes metal, non-metal and coal mining, as well as smelting and refining industries.

Study Objectives

This study will thoroughly assess the human resource situation of the mining industry through a comprehensive analysis of critical industry concerns and provide insights into possible courses of action. This diagnostic approach is to be used as the groundwork for building consensus around the nature of the industry's human resource problems. The specific industry concerns to be addressed are

- the extent of skill shortages at the professional level (mining engineers, geologists, metallurgists, etc.) and at the technical/trade level (electricians,technicians, heavy-duty mechanics, etc.);
- the extent and impact of the industry's demographics over the next 5 to 7 years (aging workforce, operations longevity);
- an assessment of the enrolment situation in education/training institutions and its impact on the industry, as well as an assessment of the factors affecting the enrolments;
- an evaluation of the level of employment of women within the various mining occupations and an inventory of initiatives to attract women into the industry;
- an assessment of the situation with respect to trades mobility and the identification fo a need for national standards in some occupations to improve training and to enhance mobility;
- an examination of the impact of immigration policies on the industry's human resource situation;
- an assessment of technological developments and their impact on skill requirements and workforce adjustment;
- the development of a profile of present and future skill requirements;
- an assessment of the basic literacy and numeracy situation of the workforce;
- an identification of the kind of training being given in mining and other occupations;

- an assessment of the effectiveness of current training programs;
- an assessment of the level of linkages between industry and education/training institutions, its effectiveness and impact on the industry;
- an assessment of the suitability of the current curriculum of education/training institutions;
- an assessment of the industry's image and its impact on the industry's ability to attract and retain qualified people.

Study Methodology

To achieve these objectives, the study will be carried out in a series of modules.

1. The Mining Industry Outlook

This module is intended to give an overview of the broad directions for the industry and provide the essential context for understanding the strategic and structural changes taking place within the Canadian mining industry and their implications for the identified human resource issues. The trends and developments in the world mining industry could be assessed in this module by examining the following areas:

- the rate of economic growth, particularly in the construction, consumer durables and machinery sectors;
- the sectoral mix of economic activity;
- the relative prices of metals and their substitutes;
- inventory practices and their influence on the demand for metals and minerals;
- technological changes and their impact on increased efficiency in production processes and on the substitution of other materials;
- Canadian industry competitiveness, the productivity trends and the relative importance of human resources.

2. *The Industry Perspective*

The purpose of this module will be to assess the current and future business environment of the Canadian mining industry and its impact on human resource issues. This can be done through a thorough analysis of the factors which are likely to affect the industry. The types of considerations that could be examined in this module include

- the development of an industry profile including the current status and market structure with information on the relative importance and concentration of mining productions, extraction, smelting and refining, and exploration/prospecting activities;

- an analysis of investment experiences and outlook;

- an assessment of the competitive environment, such as
  - the current R&D situation and outlook;
  - technological implementation and outlook;
  - orebodies outlook;
  - business environment, safety, and work organization changes;

While a sound analysis of where the industry is today will be important, there is a need for a thorough examination of the outlook of the Canadian mining industry. Whenever appropriate, the analysis will need to be supplemented by discussions with acknowledged industry experts and industry representatives.

3. *Skills Requirements*

This module will translate the broad industry directions and actions within companies (modules 1 and 2) into a comprehensive statement around the outlook for skill requirements. Thorough analysis of the skill requirements issue will be a critical component of this human resource study. The areas to be addressed in this module could include the following:

- an analysis of the trends in occupational structure;

- an examination of the segmentation of skill requirements (products, skill areas, and size of operations);

- an assessment of the critical skill requirements in entry level hiring;

- an assessment of the impact of new technology on skills;
- an analysis of the turnover situation (retention rate);
- a review of the employment dislocation and adjustment issue;
- an assessment of the impact of an aging workforce;
- an assessment of the basic literacy and numeracy situation and its impact;

The scope of this section should be such that all key issues, which could be instrumental in assessing accurately the industry's human resource outlook, are examined thoroughly. While data sources will be available to provide for an historical perspective, discussions and interviews with industry and labour experts and representatives, and with workers should be an important input to this section.

4. Skill Development, Training and Recruitment

The purpose of this section is to determine the kinds of skill requirement issues the industry is addressing, the strategies employed and the skill development capacity within the industry. Some of the considerations which could be addressed in this module include

- a through assessment of the focus and scope of ongoing training both within the industry and outside (training institutions);
- an assessment of the approaches to entry level hiring through a review of
  - the nature and extent of entry level hiring;
  - the supply sources;
  - enrolments in universities, colleges, etc.;
  - the female workforce;
  - immigration policies;
- an assessment of the relevance of apprenticeship requirements;
- an analysis of the need for and effectiveness of critical skill recruiting and an assessment of
  - the existence of a training gap;
  - the extent of trades standardization (workers' mobility);
  - the industry's image;

- an assessment of the extent of planning and control strategies for skill development, training and recruitment.

The scope of this section is wide-ranging. All skill development, training and recruitment issues which are posing problems – or are likely to do so – for the mining industry must be identified, analyzed and evaluated.

Some methodologies, which could be used to provide the information needed for these four modules, might include

- a literature search, including a review of all current reports;
- data collection and analysis using information available from Statistics Canada, Energy, Mines and Resources Canada, Industry, Science and Technology Canada, Employment and Immigration Canada and other appropriate agencies;
- international comparisons;
- case studies;
- face-to-face interviews with various representatives of the industry, labour, educational institutions and others;
- interviews with acknowledged industry experts;
- focus groups with industry workers.

The Final Report: Synthesis and Integration

Each one of the study modules should lead to a set of fundamental analyses and understandings on different aspects of the Canadian mining industry. The dynamics of the industry will have been examined in terms of the structural changes taking place. As well, technological change will have been examined in order to assess the impact of changing technology on skills. A careful analysis will have been made of all human resource issues, including supply problems, training considerations and industry-education linkages.

The process of synthesis and integration draws on the basic components of the study and brings them together in examining what the human resource implications are likely to be in the future. The study also builds on the experience and expertise of industry, labour, educational institutions and

governments to reach an array of understandings and expectations. In this regard, it represents a thorough assessment by the participants as to where the industry is headed and what the human resource implications could be in terms of employment levels, supply of labour, skill requirements and training considerations. The process of synthesis and integration should also give rise to an approach for continuing the process of assessing the human resource outlook for the industry. Moreover, the prospects of a shared consensus on the human resource opportunities and challenges in the mining industry could assist in laying the ground work for cooperative remedial actions. Thus, the importance of this section of the study cannot be emphasized too strongly.

The contractor will provide periodic progress reports, and the final document will be due ten months after the issuance of the contract. Preliminary results will be available somewhat earlier.

Appendix IV Program of the Seminar

20th CRS Policy Discussion Seminar
Human Resource Planning for the Mining Industry

March 26, 1990

Keynote address:

8:00 p.m. *Human Resources in the Canadian Mining Industry: Challenges for the Future*
Brian Ferguson, Vice President - Mining, Falconbridge

March 27, 1990

8:30 a.m. *Skill Mix among Mining Industry Workers: Trends and Outlook*
Edward McDonnell, Energy, Mines and Resources Canada

9:15 a.m. **Panel**:
Future Needs of the Industry - chaired by Pat MacCulloch

Panelists: Paul Parker, Vice President Administration, Inco
Noël Billette, CANMET
George Poling, University of British Columbia
(on sabbatical to Mining Assocation of British Columbia)

10:30 a.m. *The Public Image of Mining: Problems for the Future?*
William Bawden, Chair in Mine Design, Queen's University

Panel:
Multiskilling - chaired by Les Brown, Hemlo Gold

Panelists: Thomas Reid, United Steelworkers of America
Stephen Flewelling, Falconbridge

Luncheon Speaker:
John MacDougall, MP (Timiskaming), Parliamentary Secretary to Minister of Energy, Mines and Resources

2:00 p.m. **Panel:**
Perspectives from other organizations - chaired by Peter Richardson

Panelists: Arnold Bock, Northern Ontario Relocation Program, Ministry of Government Affairs
Tom Hennebury, Vice President - Human Resources, Northern Telecom

7:00 p.m. *Industry-University Interaction*
John Gordon, Professor, School of Business, Queen's University

March 28, 1990

8:30 a.m. *Mining Managers: Born or Developed?*
Peter Richardson, Professor, School of Business, Queen's University

9:30 a.m. *Continuing Education Programmes in Mining Schools*
Odwyn Jones, Principal, Western Australian School of Mines

10:30 a.m. **Panel:**
Issues in education - chaired by Peter Richardson

Panelists: Hugh Morris, Chairman & CEO, Imperial Metals
Brian Mackenzie, Centre for Resource Studies
Dennis Shannon, Cambrian College
Klaus Konigsmann, Vice President, Noranda Minerals

Luncheon Speaker:
The Hon. Hugh O'Neil, Ontario Minister of Mines

2:00 p.m. **Closing discussion:**
John Gordon and coordinators will draw together the observations and conclusions of the seminar; John to conclude session by synthesizing findings and recommendations for action.

Appendix V Seminar Participants

Will Bawden
Mining Engineering
Queen's University

Dick Beard
Northern Development and Mines
Kenora, Ontario

Noël Billette
CANMET
Ottawa, Ontario

Arnold Bock
Ministry of Government Services
Toronto, Ontario

Les Brown
Hemlo Gold
Marathon, Ontario

Bruce Campbell
Ontario Mining Association
Toronto, Ontario

Richard Chaykowski
School of Industrial Relations
Queen's University

Geoffrey Cox
Royal School of Mines
London, England

John Dixon
Geological Sciences
Queen's University

Brian Ferguson
Falconbridge Limited
Toronto, Ontario

Stephen Flewelling
Falconbridge Limited
Sudbury, Ontario

John Gordon
School of Business
Queen's University

Tom Hennebury
Northern Telecom
Mississauga, Ontario

Moira Jackson
Centre for Resource Studies
Queen's University

Odwyn Jones
Western Australian School
of Mines
Kalgoorlie, Australia

Jim Kelly
Career Planning & Placement
Queen's University

Klaus Konigsmann
Noranda Minerals Incorporated
Toronto, Ontario

Pat MacCulloch
CRS Distinguished Visitor
Toronto, Ontario

John MacDougall
MP (Timiskaming)
Parliamentary Secretary to
Minister of Energy, Mines and
Resources

Brian Mackenzie
Centre for Resource Studies
Queen's University

Bob Mason
Department of Geological Sciences
Queen's University

Raimo Matikainen
Helsinki University of Technology
Helsinki, Finland

Ed McDonnell
Energy, Mines and Resources
Ottawa, Ontario

Hugh Morris
Imperial Metals Corporation
Vancouver, British Columbia

The Hon. Hugh O'Neil
Ontario Minister of Mines
Toronto, Ontario

Ford Osmond
Iron Ore Company of Canada
Labrador City, Newfoundland

Paul Parker
Inco Limited
Copper Cliff, Ontario

George Poling
University of British Columbia & Mining Association of B.C.
Vancouver, British Columbia

Bruce Regensburg
Synscrude
Fort MacMurray, Alberta

Thomas Reid
United Steelworkers of America
Toronto, Ontario

Peter Richardson
School of Business
Queen's University

Malcolm Scoble
Dept of Mining Engineering
McGill University
Montreal, Quebec

Karen Seitz
Placer Dome Inc.
Vancouver, British Columbia

Dennis Shannon
Cambrian College
Sudbury, Ontario

Reg Smith
Metallurgical Engineering
Queen's University

David Walters
Ministry of Northern Development and Mines
Timmins, Ontario

Margot Wojciechowski
Centre for Resource Studies
Queen's University

The Centre for Resource Studies

The Centre for Resource Studies (CRS) was established in 1973, under the sponsorship of Queen's University, the federal Department of Energy, Mines and Resources, and The Mining Association of Canada, to carry out a program of research and publication on mineral policy issues.

The Centre provides opportunities for multidisciplinary research in resource studies at Canadian universities, furnishes reliable information on matters related to mineral resource policy, and promotes closer liaison between government, industry and other concerned groups. The research program is carried out both at the Centre and by means of contracts with qualified investigators, usually at Canadian universities. Small exploratory studies are also funded, through a system of grants-in-aid of research. CRS Policy Discussion Seminars involve representatives from governments, industry, universities, labour, and other interested groups in working sessions on issues of current concern. Through this program of research and seminars, and the resulting publications, the Centre contributes to informed discussions and a better understanding of significant issues.

The Centre is governed by a Board of Directors which establishes general policy and priorities for research. The chairman is Dr. C.G. Miller and the executive director is Mrs. Margot Wojciechowski. There are sixteen Directors, – nine nominated by Queen's University, four by The Mining Association of Canada, and three by the federal government. Guidance on the research program, together with discussion of policy issues and other matters, is provided by the Advisory Council. This body comprises all researchers associated with the Centre, together with members appointed from such groups as governments, industry, labour, and other interests. A Research Advisory Committee aids in the development of projects and the selection of research proposals. The executive director and staff are responsible for the work of the Centre within this framework.

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